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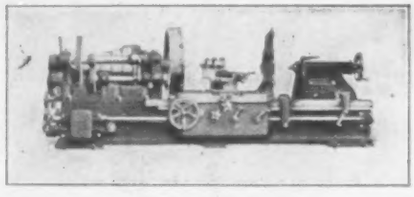

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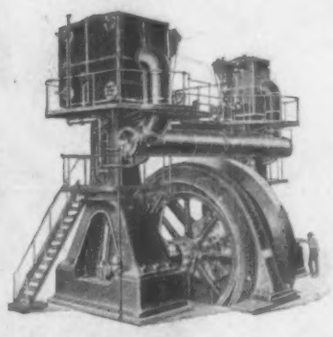

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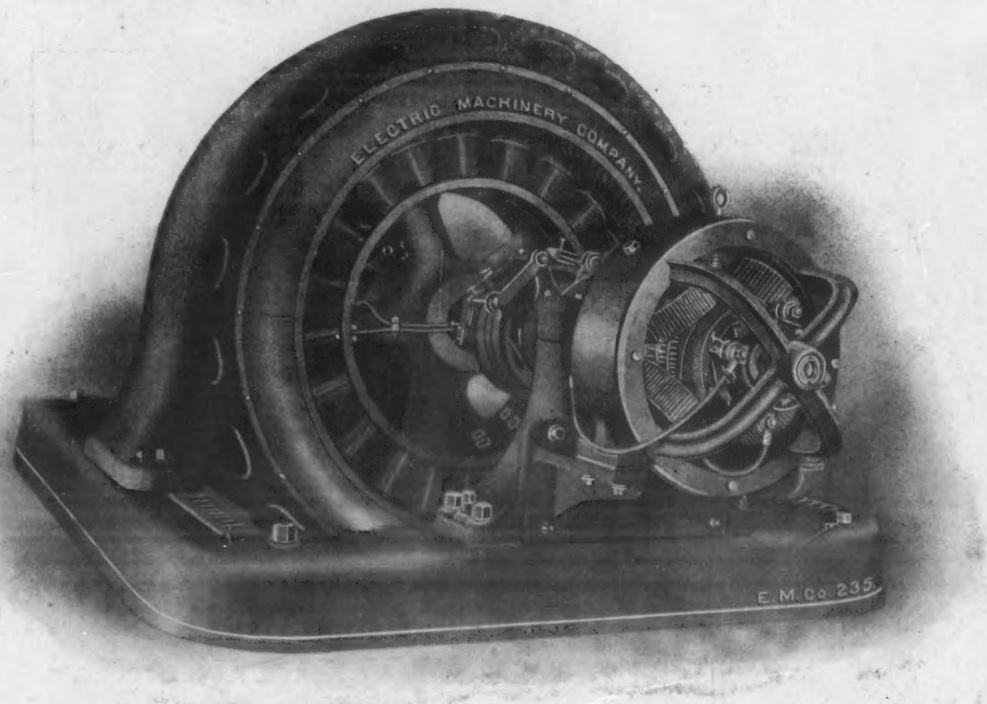

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Hydraulic Dam Construction in Marin County, California

Wyatt H. Allen.

In a paper entitled "Recent Practice in Hydraulic-Fill Dam Construction," very lately presented before the American Society of Civil Engineers, by Mr. James D. Schuyler, the author clearly demonstrates that, while the requirements involved in the design of any earth-fill dam may be fulfilled by the usual methods of moistening, rolling and tamping, due care being exercised in construction and selection of materials, the system known as the hydraulic fill is cheaper and more efficient.

That it is not always practicable to employ this method of construction may be readily realized upon consideration of the natural advantages necessary thereto, primarily, proper materials, natural fall or head to produce pressure and water in sufficient quantity for excavating and depositing material.

FIG. 1.
VIEW OF EAST END OF LAKE LAGUNITAS, LOOKING UP BILL WILLIAMS GULCH.

The Phoenix Gulch Dam of the Marin County Water Company was constructed by the hydraulic method in so far as the deposit of material in the fill was concerned, but owing to the lack of a sufficient quantity of water under pressure, only a small proportion of the excavation was accomplished by this means.

FIG. 2.
VIEW OF BORROW PITS AT WEST END OF DAM.

For many years the company has supplied water to San Rafael and the adjacent country in Marin County, the supply being derived from Lake Lagunitas, which lies on the northeasterly slope of Mt. Tamalpais, at an elevation of a little more than 700 feet above sea level. The lake is fed by springs and the run-off of rainfall over the adjacent water shed. The water of Lagunitas is favorably known for softness and purity.

With the rapid increase of suburban population during recent years the inadequacy of the water supply was only too apparent, and to meet this condition plans for an auxiliary reservoir were formulated. The final choice of the location is at the confluence of Phoenix and Bill Williams' gulches, approximately one and one-half miles west of Ross Station, on the North Shore Railroad, and at an elevation of 100 feet above sea level.

The incidents and considerations leading to the selection of this site, while interesting in that they serve to show the short sight of some individuals connected with county affairs and the discouraging attitude of a minority toward corporations engaged in progressive development, are not for discussion here.

The dam is designed for an ultimate height of 90 feet to be carried up only 75 feet until such time as it becomes necessary to increase the storage. The slopes are 2 to 1 on the back slope and 2½ to 1 on the water face. The length of crest for the 75-foot height is 285 feet, and the transverse width of crest is 20 feet for the height of 90 feet.

For a width of 20 feet up and down stream along the longitudinal axis of the dam, the surface of the ground was removed down to bed rock, thoroughly cleaned and all crevices cemented. During the construction the best material was selected and placed in the cut forming a key and core wall 20 feet in thickness and of material impervious to water. The top soil was entirely removed from the site of the dam and the entire area of the reservoir cleared of brush, trees, etc.

The location of the borrow pits, as will be seen in Fig. 2, is just above the dam on the north hillside. The material consists of layers of stiff, blue clay overlaid by clayey brown earth interspersed with boulders and small rock. The selection of material from the pits consisted in placing the clayey earth and small rock on the back face or wall of the dam, while the pure clay was distributed over the center core and water face.

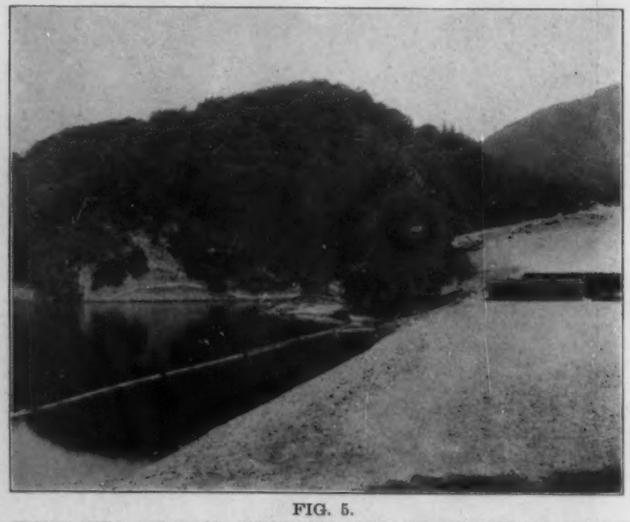

FIG. 5.
WEST END OF DAM, SHOWING END OF TRAMWAY ABOVE WATER.

FIG. 4.
VIEW OF DAM LOOKING EAST, SHOWING SPILLWAY UNDER CONSTRUCTION.

Sluice boxes were constructed on trestles running down the hillside from the borrow pits, heading fairly close together and spreading widely apart toward the bottom of the dam site. The boxes were made in sections 12 feet in length and 1 foot wide by 2 feet deep. Each section was provided with iron hooks to clamp to the section following, and the supporting bents were made sufficiently wide to allow of the boxes being shifted sideways 8 to 12 feet.

Near the head of each sluice box was a driveway with an opening and chute leading into the box, allowing material moved by scrapers to be dumped into it. A stream of water under pressure issuing from a nozzle placed just below the trap, served to break up the mass and carry it into place at the end of the sluice box.

As the overhanging banks of the borrow pits were blasted out and scraped to the sluices it became possible to use streams of water directed against the banks to undermine and wash the material directly into the boxes.

The supply of water was obtained by tapping the Marin County Water Co.'s main pipe line leading from Lagunitas to the subsidiary reservoirs in San Rafael. Three 3-inch

taps were taken off, but on account of the size of the main pipe it was not always possible to use more than two of the outlets without decreasing the town supply and lowering the water in the subsidiary reservoirs.

The streams from the hose nozzles were effective against the looser material found in the borrow pits, but made no impression on the blue clay. It was necessary to blast this and then break up the loosened mass by means of the water. All rock was laid aside to be later used in rip-rapp on the water face of the dam.

The work of placing material in the fill was not commenced until late in January, 1906, owing to a shortage of water due to extremely late rains. All grubbing and clearing had been previously completed and the work was carried on during wet and dry weather almost continuously to its completion in June.

During the heaviest storms it became impossible to work teams in the clay, but to offset time lost in this way a considerable amount of night work was done by the light of gasoline torches.

By the time the fill was well started a steam pump and boiler were installed by the contractor for pumping water from the gulch for use at the borrow pits. Sufficient clear water was by this time flowing down the creeks to enable the pump to add very materially to the pressure water supply, and the amount of material moved per 24 hours was correspondingly increased, reaching at times over 1,200 cubic yards. The total fill is slightly in excess of 73,000 cubic yards.

The scour outlet from the reservoir consists of a 30-inch extra heavy cast-iron pipe laid in concrete beneath the dam. At the inner end a 90-degree elbow turns vertically upward, the mouth being provided with a bronze seat for a stand pipe or "bottle" valve fitting snugly against the bevelled surface of the bronze.

The standpipe portion of the valve is supported from a steel tower, Fig. 5, by means of a stem with screw and nut attached to its upper end. Guides are provided to seat the standpipe accurately into the lower half of the valve, and a ratchet lever fitting the nut is operated from a platform at the top of the tower to raise or lower the stand pipe.

With the reservoir full a rise of four inches of the upper portion of the valve or stand pipe is sufficient to discharge all the water the creek below the dam is capable of carrying, without overflowing its banks.

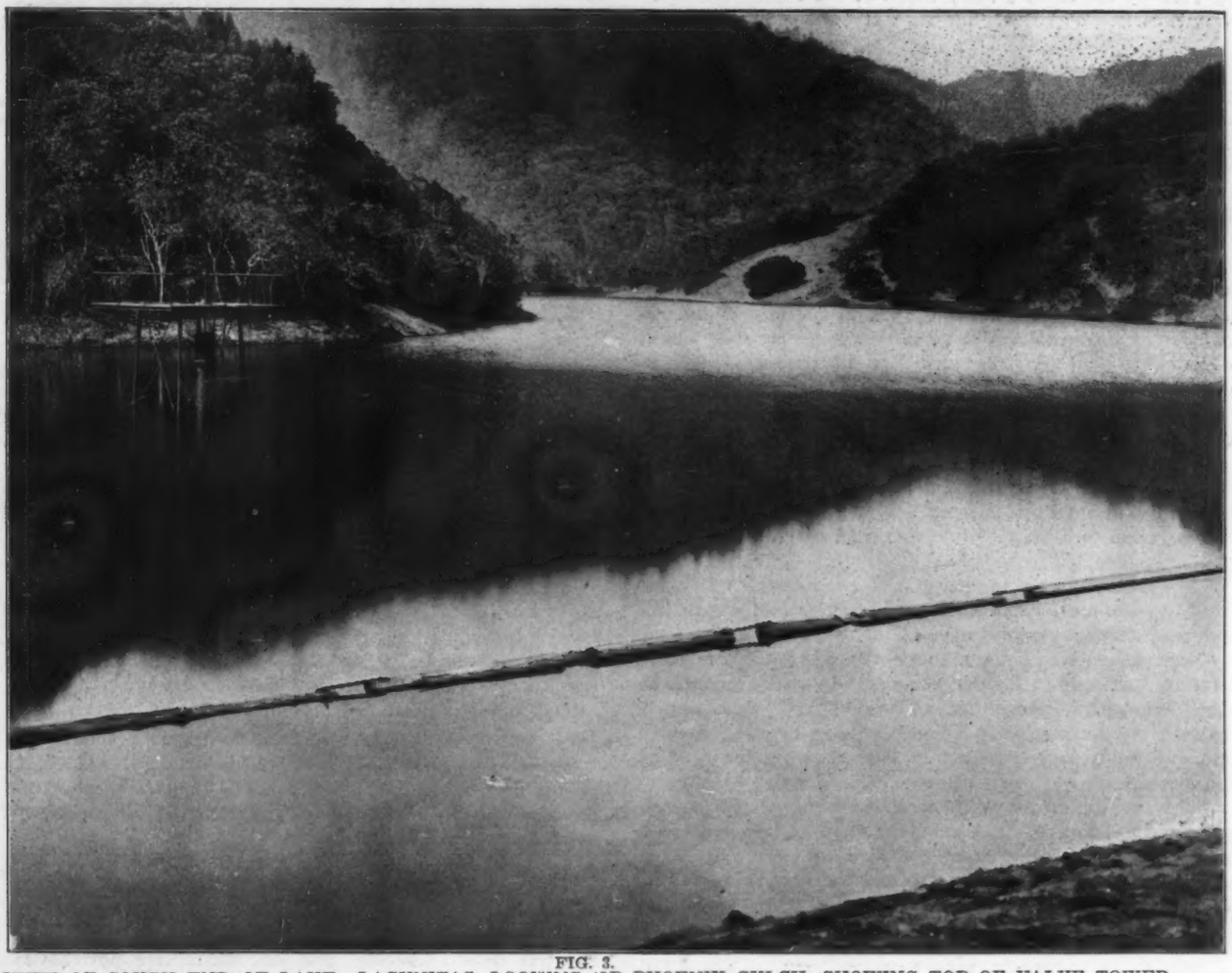

FIG. 3.
VIEW OF SOUTH END OF LAKE LAGUNITAS, LOOKING UP PHOENIX GULCH, SHOWING TOP OF VALVE TOWER.

The valve and tower were designed by Mr. Wynn Meredith, now of the engineering firm of Hunt, Dillman, Meredith & Allen, Inc. The tower legs are built up of 4-inch screw pipe with screw flanges bolted together every ten feet. The legs rest upon concrete piers to which are bolted special angle flanges inclined from the vertical to allow for the batter of the tower legs. The lateral bracing is made up of light angle iron and the diagonal bracing of round iron with turnbuckles. Plates with lugs forming a bolted joint with the bracing are inserted between the flanges at the joints of the legs.

The bottom of the spillway is 6 feet below the crest of the dam. The spillway is 16 feet in width and 6 feet in depth, tapering as the grade increases to 10 feet in width.

It is constructed of redwood throughout and carries spill water well below the down-stream toe of the dam.

On the back face of the dam beams are provided at elevations of 30 feet and 60 feet above the down-stream toe. The beams are 5 feet in width and slope inward toward the dam, draining into paved gutters for leading rain water off the face.

Water from the reservoir is pumped into a small basin on the hillside above, and is piped thence into the main pipe line leading to San Rafael and other points. A tramway consisting of heavy timbers bolted to concrete piers leads down into the water from an elevation slightly above the crest of the dam. Rails are laid on the timbers and a car containing the pumping plant is lowered or raised along the rails by means of a hand winch at the top of the tramway, thus keeping within the suction limit of the pump as the water recedes.

The pumping plant consists of a triple-cylinder marine gas engine directly connected to a triplex pump, the whole being mounted on the car, together with a gasoline supply tank, etc. The plant has a normal capacity of 500,000 gallons per 24 hours and is arranged to be speeded up to reach a capacity of 800,000 gallons when necessary. The maximum lift required is 200 feet.

The fill was contracted for at a definite price per cubic yard of material placed in the fill, the grubbing and clearing at a price per acre, the stripping of the top soil from the dam site and borrow pits per cubic yard in place, and the remainder of the work was done on the force account plus a percentage. The company furnished all materials, such as pipe, cement, rock, etc., and a definite agreement was made as to daily wage of labor of different classes and the cost of teams.

The drainage area tributary to reservoir is approximately six square miles. The surface area of the reservoir when full is 16 1-3 acres and its capacity 118 million gallons. If the dam is raised to a height of 90 feet a storage of 220 million gallons is obtainable.

The method of placing material in the fill with water, insured an absolute compactness and tightness in the junction with the material already in place. The quality of material used could hardly be better, though this very quality made it extremely difficult to handle. Lumps and sticky masses of clay frequently clogged the sluices and necessitated constant watchfulness. The center portion of the dam was kept concave during construction, thus insuring the flow of the finer material to this portion.

The rip-rapp on the water face was laid by hand to line, and later a boom of logs chained together was stretched across the water in front of the dam to break the wave action. The work was completed and the reservoir filled in June of 1906.

LIFE OF WOODEN POLES.

The German Postal and Telegraph Department has recently published statistics collected during a period of 52 years on the life of wooden posts impregnated with different preservative substances. The number of posts under observation amounts to nearly 3,000,000, and the following are the average results obtained:

Poles Impregnated with	Length of Life.
Sulphate of Copper	11.7 years
Corrosive Sublimate	13.7 years
Creosote	20.6 years
Unimpregnated	7.7 years

The manner of preparing the poles has been improved from time to time, and this is clearly shown in a further table giving the average length of life of the poles under different methods of treatment with each preservative at different periods. For example, in 1883, with sulphate of copper the average life was 9.4 years, while in 1903 the method of treatment had been improved so that an average life of 13.3 years could be obtained.—"Electrical Magazine."

THE DEVELOPMENT OF THE GAS ENGINE.*

By Dugald Clerk, M. Inst. C. E., F. C. S.

It has been my fate to be associated with the development of the internal combustion motor for the past thirty years. My attention was first drawn to the gas engine, as it was then called, at the end of 1876. At that date the only types of engine in operation were the non-compression engines of Lenoir and the non-compression free piston engine of Otto and Langen. In 1876 the Lenoir engine had practically disappeared from the market, and the only commercial engine then in use was the Otto and Langen. This was a very cumbersome engine, operated with great noise and much recoil, and the largest of the type in use in the world did not exceed 3 horsepower. In that year the user of motive power had but little choice. He was practically confined to the steam engine, both for small and large powers. The motive power user to-day is in a more fortunate position. Many types of engines and motors compete for his favor.

These thirty years have seen a marvelous development of the gas engine, and an extension of the use of different fuels which has caused the old title "gas engine" to disappear, and the comparatively new title, "internal combustion motor," to come into use.

The gas engine originated, as its title clearly shows, in a form of engine adapted to use the coal gas of our towns. In its present form, however, other gases are used, such as producer gas in its various forms, coke oven gas and blast furnace gas; light oils are used, as petrol; heavy oils are used, such as refined and crude petroleum; and even alcohol has been applied for the purpose of producing motive power. Hence the abandonment of the old term gas engine, and the use of the modern term internal combustion motor.

Motors in Competition.

Although the gas engine has made marvelous progress, both from the practical and the scientific points of view, yet its advance has been attended by no small advances in the mechanism and economy of the steam engine, and the development of an entirely new form of steam engine specially suited for large powers. I refer, of course, to the steam turbine. The steam turbine, so far as practical use is concerned, was entirely originated by the Hon. C. A. Parsons in 1884, so that it has attained to its enormous developments both on land and sea in the short period of twenty-two years.

The practical introduction of electricity, both for lighting and motive power, has also been accomplished in the same period. Little was known of electricity from a practical standpoint in 1876. Indeed, as late as 1881 the electric light was only beginning, and electric motive power was but little thought of.

The development, mainly in this country, of the high-speed reciprocating steam engine direct coupled to a dynamo, and the steam turbines also direct coupled, soon led to the comparatively economical production of electricity. Accordingly, we now find the following motors, all in competition one with the other:

- Steam
  - Reciprocating.
  - Turbine.
- Gas
  - Coal gas.
  - Producer gas.
  - Coke oven gas.
  - Blast furnace gas.
  - Petrol,
  - Heavy oil.
  - Alcohol.
- Electricity.

(*From a lecture delivered to the Sheffield Society of Engineers and Metallurgists, November 5th, 1906, at Firth Hall, Sheffield University.)

We can thus have motive power in a factory for any purpose, either from steam, in the form of a reciprocating slow-speed or high-speed engine, or in the form of a steam turbine, and in a town we can have an internal combustion motor using either coal gas, a producer gas, or a heavy oil. For stationary engines in towns, the other gases are not applicable, and petrol and alcohol are not preferred on account of their relative volatility and inflammability. The small user of motive power may also take electricity from the electric mains. Where lifts are operated, too, in many towns a high-pressure system of water supply is arranged.

ation. In these journals I find the case against gas, both for power and light, set forth with great detail, and sometimes with no little exaggeration. On the other hand, the reading of our leading gas journals is almost convincing that no good can some from electricity or electricians. There is no place so excellent as the gas journals for discovering the various troubles which occur in electric light stations, and in supplying electricity for motive power. Such competition is healthy and tends to progress.

Heat Efficiency.

HEAT BALANCE-SHEET FROM 1882 TO 1900, WITH OTHER PARTICULARS OF ENGINES.

Name of Experimenter.	Year.	Dimensions of Engine.	Revolutions per Minute.	Compression.	Expansion.	$\frac{1}{r}$	E Standard Air-Cycle.	Heat Proportions.					I.HP. / E	Heating Value of Gas Taken.	Type of Engine.
								I.HP.	Rejected to Water Circulation.	Rejected to Exhaust.	Difference Values.	Total.			
		Diameter Stroke. Inches. Inches.													
Slaby	1882	6·75 × 13·7	160	PV^{1}	$PV^{1\cdot37}$	$\frac{1}{2\cdot66}$	0·33	0·16	0·51	0·31	0·02 radiation	1·00	0·48	Lower	Deutz.
Thurston	1884	8·5 × 14·0	160	..	..	$\frac{1}{2\cdot66}$	0·33	0·17	0·52	0·155	0·155 conduction and radiation	1·00	0·515	Lower	Crossley.
Society of Arts Trials .	1888	9·5 × 18·0	160	$PV^{1\cdot35}$	$PV^{1\cdot423}$	$\frac{1}{3\cdot5}$	0·39	0·221	0·432	0·355	..	1·008	0·565	Lower	Crossley.
Society of Arts Trials	1888	9·02 × 14·0	200	$PV^{1\cdot343}$	$PV^{1\cdot55}$	$\frac{1}{3\cdot2}$	0·37	0·211	0·352	0·398	0·039 unaccounted for, including rejected in blank air charge	1·00	0·575	Lower	Griffin (6-cycle).
Kennedy	1888	7·5 × 15·0	210	..	$PV^{1\cdot398}$	$\frac{1}{3}$	0·36	0·209	.	.	..		0·585	Lower	Beck (6-cycle).
Capper	1892	8·5 × 18·0	160	$PV^{1\cdot388}$	$PV^{1\cdot374}$	$\frac{1}{3\cdot4}$	0·39	0·228	0·389	0·405	..	1·022	0·58	Lower	Crossley.
Robinson	1898	10·0 × 18·0	170	..	..	$\frac{1}{5\cdot17}$	0·48	0·287	0·33	0·383	..	1·00	0·60	Lower	National.
Humphrey	1900	26·0 × 36·0 2 Cylinders (A)	150	..	..	$\frac{1}{5}$	0·47	0·278	0·242 in jacket water and exhaust valve	0·48	..	1·00	0·59	Higher	Crossley.
		(B)	..	$PV^{1\cdot391}$	$PV^{1\cdot388}$			0·31					0·66	Lower	..
				$PV^{1\cdot419}$	$PV^{1\cdot404}$										
Witz .	1900	51·2 × 55·13	95	.	..	..	0·55	0·28	0·52	0·20	..	1·00	0·51	Higher	Cockerill.

The Gas Engine with Town Gas.

The advocates of these various systems have, of course, much to say for themselves, and the general competition has resulted in the installation in works of motive power obtained in these different ways on quite a considerable scale. The fact is that each type of motive power has its own advantages and disadvantages, and there are varying circumstances which in different cases render one to be preferred before another.

I am here to-night, as an advocate of the gas engine in its old-fashioned form, that is, the internal combustion motor driven by town gas. I am not blind, however, to the good points of the steam engine or to the excellence of the electric motor, and I shall do all I can to avoid overstating my case.

A perusal of our excellent electrical journals furnishes interesting evidence of the enthusiasm of their editors for the cause of electricity, both as supplying power and illumin-

The development of the internal combustion motor has not been so startlingly rapid as that of the steam turbine, but in one essential point it assumed a leading position, and it has retained that position over all other prime movers. I refer to the heat efficiency of the engine. The early gas engines of the now prevailing compression type had an indicated efficiency of about 16 per cent. This efficiency has been slowly increased, until at the present time gas engines are in regular use having an indicated efficiency of 35 per cent., and even a little over. No steam engine efficiency can be compared with these figures. On this point the steam engine falls far short of the gas engine.

The accompanying table shows the gradual improved effect in the heat efficiency of the gas engine. From this table you will see that as years went on, the efficiency slowly increased, until some 30 per cent. of all the heat given to the engine was converted into indicated work. Since this table was prepared, the Report of the Committee of the Institution of Civil Engineers on the "Efficiency of Internal

Combustion Engines" has been published, and the results of tests are given with three National gas engines at the National Company's works at Ashton-under-Lyne. From these tests it appears that the brake-efficiency of these three engines, of 5-horse, 21-horse, and 52-brake horse, respectively, was 26.1, 28, and 29.9 per cent., respectively, and the gas consumption per brake horsepower per hour was 16.87, 15.84 and 14.9 cubic feet, respectively, with gas under 600 B. Th. U. per cubic foot.

Very similar results were obtained from Crossley engines by Professor Burstall in a recent test. I believe, however, on the Crossley engines, the compressions adopted were somewhat higher.

Study of Heat Losses.

In a paper read before the Royal Society in the early part of this year, I described a new method of studying the heat losses and other phenomena of the gas engine cylinder by means of a special indicator diagram. Those of you who are familiar with gas engine matters will know that many years ago experiments were made on the explosion and cooling curves of mixtures of coal gas and air in a closed chamber by means of an indicator registering upon a rotating drum. These experiments enabled us to determine the rate of cooling of an explosion when exposed in a vessel of certain dimensions, but having fixed walls. No method seems to have occurred to anyone of determining the rate of cooling in the gas engine cylinder itself with the piston moving. The experiments described in the Royal Society paper referred to by me very clearly show the rate of cooling in any cylinder. They consisted in taking a diagram from a compression explosion in the ordinary way, but so arranging matters in the engine that the exhaust valve and the charge inlet valve were held closed immediately the charge was taken into the cylinder. In this way, when the engine reached the exhausting point, no escape was possible, and the whole of the hot gases were compressed and expanded, producing a series of gradually rising and falling lines, which indicated exactly the loss of heat to the cylinder during the alternate movements of expansion and compression. Diagrams were shown illustrating these experiments.

Large Engines.

Gas engines by English makers are built and sold in very large numbers. At the present moment the weekly output exceeds anything before experienced in Great Britain, and engines of English construction are freely sent to nearly the whole of the Continent, our colonies, Japan, and even America. British makers have confined themselves mostly to engines up to 300 brake horsepower, as they have found these sizes, for the present, to be the more commercial. Continental makers have devoted themselves to larger engines, and engines have been built of considerable power. Of these large engines, two main types appear—Otto and Clerk. For the smaller engines in this country, the Otto cycle is practically supreme. Some English makers, however, have taken up the large engine problem, and are making good progress. At present the large engine is rapidly nearing the paying commercial stage. In using the term "paying commercial stage," I refer to the gas engine builder, and not to the user, because many large gas engines have been built and applied to the great advantage of the user, although often at a loss to the maker. The cost of these large engines has been too great; but there are methods of bringing it down, and I have no doubt in a very short time we shall have much more powerful large gas engines with very much less weight of metal, and consequently less cost.

POLYPHASE SYSTEMS OF GENERATION, TRANSMISSION AND DISTRIBUTION.*

By M. A. Sammett, A. M. Can. Soc. C. E.

Every electrical development possesses some typical peculiarities which should be the determining factors in the selection of the frequency of the system as a whole, as well as the selection of the generating and distributing systems as to phases, that is, whether it should be two or three-phase. These are the problems with which we will concern ourselves in the discussion of polyphase systems, with a transmission line of 100 miles or less and pressures up to and including 50,000 volts at the receiving end.

Whatever the generation and distribution, the transmission of power is always accomplished by three-phase. This arrangement allows of most economical transmission of power with a given drop in the line. While the transmission of power is invariably accomplished by three-phase, the generation and distribution is often by two-phase.

Modern engineering practice shows, however, the abandonment of the two-phase generator in connection with hydro-electric power houses, where power is to be transmitted and consequently transformed from two to three-phase. The common belief of the simplicity of the two-phase generator and switchboard is more imaginary than real and came about as a result of clinging to the more familiar two-phase generator which at the time just preceding the era of generation for transmission purposes was the standard apparatus, answering best the needs of small central stations with a lighting load, the amount of power forming a very small proportion of the total load.

It must be admitted that a two-phase system for distribution purposes is somewhat simpler to operate than a three-phase system. The two-phases may be controlled independently for single-phase lighting circuits, without any appreciable effect of one phase on the other.

In the case of motor connections on two-phase circuits, all that is necessary is to connect the two transformers with the primary coils to the line, and the secondary coils to the motor. No special attention is required as to polarities of transformers. The impedance of transformers need not be the same for proper division of load, as is essential in connections of three-phase installations.

It was this at first sight simplicity which appealed to the engineer in laying out the first hydro-electric power houses, and even at the present time some engineers persist in their preference for the two-phase generators, and at the receiving end go through another transformation from three to two-phase in order to supply two-phase current at the distributing end.

Let us take up the generating plant first and see which of the two systems, three or two-phase, is more efficient as well as more economical.

Power House.

It is pretty well known that for a given capacity, speed and voltage, at a given frequency, the three-phase generator will prove the more efficient machine. Manufacturers standardizing apparatus use the same frames and punchings for the two different types. This enables the manufacturer to turn out a better three-phase generator as to efficiency and heating, retaining the same core loss. Should he, however, select to keep the same density in the copper of the three-phase as in the two-phase machine, he will be in a position to reduce the magnetic flux by virtue of the larger number of turns that can be accommodated in the same slots, and thus considerably reduce the core loss. Inasmuch as the

*From a paper read before the Canadian Society of Civil Engineers, November 15, 1906.

core loss in machines of large capacity is considerably greater than the copper loss, this will result in a material increase in the efficiency of the generator.

Switchboard.

Taking up next the switchboard, we will find that the only advantage the two-phase board has in comparison with the three-phase, is the saving of one ammeter.

All busbars, oil-switch contacts and switch compartments, all cables from generators to switchboard and from the board to the transformers are reduced in the ratio of 4:3, and while 15.6 per cent. larger cross-section of copper is required in the instance of the three-phase installation, maintaining the same current density, the 25 per cent. saving in the number of individual parts necessary for the installation will be in favor of the three-phase board.

Transformers.

The use of two transformers for a given load allows a greater individual transformer capacity, and therefore a more efficient transformer. This would have been a decided advantage, favoring the two-phase system, were it not for the fact that the transmission of power is to be by three-phase. To accomplish this phase transformation by the well-known Scott connections, unless all transformers are provided with a heavier high-tension winding, the transformer capacity would of necessity be reduced, due to a higher current in the three-phase winding, namely, that of 115.6 per cent. of the normal current. Should, however, the transformers be designed with provision made for this higher current, it would necessitate larger transformers, or in other words, a more expensive installation. Beside this increased transformer capacity another disadvantage must be added, that of a possible resonance with T-connected transformers for two-phase three-phase transformers. Whenever one of the phases is open, due to a failure of making proper contact of various switches or any of the auxiliary connections, the high reactance of the high-voltage transformer will get in series with the capacity of the transmission line and a resonance is likely to take place with the consequent disastrous results.

We have shown the advantages of using a three-phase generator. This advantage is further augmented by the possibility of using transformer connections with which the danger of resonance is eliminated. Of the transformer connections in vogue, there are two which are free from the danger of resonance, namely, delta to delta for step-up and delta to delta for step-down, or delta to Y and Y to delta. Neither of these two has the objectionable characteristic of resonance, and while the delta to Y and Y to delta is selected for transmissions where highest voltages are made use of, it is the delta to delta which gives the most reliable service. With the latter style of connections, should one of the transformers fail, as soon as this transformer is cut out, the service may be restored. This latter connection, which insures both continuity of service and freedom from resonance, is introduced now on one of the 60,000-volt transmission lines and is destined to become the standard, inasmuch as high-tension transformers of 60,000 volts as well as the insulators, especially if the latter are carefully selected and tested, have the requisite factor of safety, making the resort to the Y connections, at a sacrifice of continuity of service, unnecessary.

Distributing System.

The considerations which held true in the discussion of the transmission line will also hold true in the distributing system. The three-phase delta connections should be made use of, since on motor service a complete shut-down due to a failure of one transformer must be carefully guarded against. Again, the three-wire three-phase distribution will result in a saving of 25 per cent. of copper and insulators. It will reduce the maintenance expense by the same percentage.

The advantages thus enumerated show clearly the desirability of three-phase distribution from the purely commercial standpoint and still more so from the point of view of reliability and permanency of supply. Some engineers object to the three-phase distribution on the ground of the difficulty of balancing loads. This objection must not be given much importance. With the mixed load of lighting and power, the power load has an equalizing tendency on the balancing of the system, and with some attention given to the proper division of the connected lighting load no difficulty will be encountered.

The station records should be carefully watched, and occasional readjustment of the load, based on station records as well as tests of individual installations, will permit of as careful a balance as one may desire.

The comparison of motors can best be made from a summary of a convention paper by Mr. Bradley McCormick, read recently before the American Institute of Electrical Engineers. Given two similar frames without windings, how shall the two-phase and three-phase windings differ in order to secure proper operation? What will be the comparative losses if the two machines are given the same rating?

Mr. McCormick's answer to these questions is as follows:

1. A two-phase machine should have 22 per cent. more conductors per slot than the corresponding three-phase Y connected machine, designed for the same voltage and flux per pole.

2. The magnetizing current is the same in both the two and three-phase machines when expressed in percentage of the current, which corresponds to the full-load output.

3. The copper loss of the two-phase machine is 12 per cent. higher than that of the three-phase.

4. The leakage factor of the two-phase machine averages 25 per cent. greater than that of a three-phase machine, therefore the power factor is lower.

Actual results show from 1 to 3 per cent. lower power factors.

These considerations show that the two-phase machine will have a higher temperature rise as a result of a higher copper loss. For the same reason the efficiency of the two-phase motor will be lower. The slip of the two-phase machine will also be greater. Tests and theoretical calculations show 20 per cent. greater slip.

Thus we see that the two-phase induction motor is a poorer motor for the central station company, due to a poorer power factor. It is also less advantageous to the power user, as a smaller efficiency means a larger motor input for a given output. The higher temperature rise will result in a shorter life and larger slip will mean a greater fluctuation between synchronous, partial and full-load speeds.

While the three-phase service should be made standard, two-phase motors may be used by the aid of three-phase two-phase transformers. This, however, should be discouraged, as such transformers require special taps, which make them more expensive, especially so when core type transformers are used. It also means the carrying of a stock of these special transformers as spare units.

Frequency.

The frequencies most widely used on this continent are those of 60 and 25 cycles. While other frequencies are made use of, these are the predominating ones.

As far as the transmission line is concerned, the lower the frequency, the less the induction drop, the smaller the charging current and the better the regulation. It is a foregone conclusion that as a purely transmission problem we will have to adopt the 25-cycle frequency.

The speeds of turbine-generator units are limited by the number of wheels, type, head and output. Therefore a wider range of speeds permissible with a 60-cycle system will enable

the selection of the most efficient generator-wheel combination.

The switchboard under the two frequencies is unaffected. All meters and potential and current transformers are designed for satisfactory operation on frequencies from 25 to 125 cycles.

The transformers built for 25 cycles are a much more expensive piece of apparatus as well as less efficient than when built for 60 cycles. Considering that there is with a generation, transmission and distribution of power a total transformer capacity equivalent to from three to four times the capacity of the generating apparatus, one will readily see the advantage of a higher frequency. This, however, must not be done at a sacrifice of other considerations, such as excessive charging current in transmission or extremely poor regulation.

With incandescent lighting, while 30 cycles is the limiting frequency, 40 cycles is unsatisfactory when moving objects are viewed by it. On this continent 60 cycles is the standard frequency for such a service, while 50 cycles is European practice. For arc lighting 40 cycles is the limiting frequency. Lower frequencies are made use of in the application of the recently developed mercury vapor converter and magnetite lamps. This new system, however, will probably have to go through a process of further experimenting. The conservative investor will still select the higher frequency series alternating enclosed arc lamps.

Analyzed from the standpoint of frequency, induction motors show characteristics which make it difficult to decide as to the best motor. As a rule lower frequency motors are adaptations to standard 60-cycle frames and punchings, hence their performance does not show characteristics of the same high standard. Of course the low frequency motors have advantages of their own, such as better starting torque, higher instantaneous but not continuous overload capacity and lower speeds.

The principal factors in favor of the 60-cycle motors are better continuous overload capacity and also a cheaper product commercially as a result of higher speeds. Therefore, with equally good performance as to efficiency and heating, the 60-cycle motor will still be ahead of the 25-cycle motor.

The suitability of low frequency synchronous converters for railway work is a well-established fact. While 60-cycle synchronous converters are used for such purposes, they are rather an exception and their operation is less satisfactory. What should then, under the circumstances, be a desirable way of supplying street railway loads without resort to frequency changes? The latter are out of the question, due to excessive cost, beside the great reduction in the efficiency of the systems, resultant from their use.

Motor-generator sets may be and are advantageously used in this connection, and while not possessing the advantages of 25-cycle synchronous converters, have features which make them particularly suitable for use on long-distance transmission systems, permitting of a partial or complete control of the power factor of the system depending as to whether induction motors or synchronous motor sets are used.

Wherever large capacity is present, due to long transmission lines, induction motor generator sets of large size can be used to great advantage. For perfect control of the power factor of the transmitted power, synchronous motors should be employed, as in this case the regulating of the field excitation allows of a close control of the power factor of the transmitted energy, allowing the maximum energy for a given current, and under certain conditions will permit of carrying the load at unity power factor in the generating and transforming apparatus and transmission line.

While the synchronous converter is the most efficient of the three means of supplying railway loads, whenever this load constitutes only the minor portion of the total output of the plant, the interests of the lighting and power load cannot be sacrificed for a most efficient conversion of the alternating current to direct current for railway purposes.

In our discussion of frequency we may conclude that for a mixed load of lighting and power with a railway load not exceeding one-third of the total power generated, 60 cycles will be the frequency to select.

The regulation and capacity or charging current are decidedly in favor of the 25-cycle transmission. The results for the 60-cycle system, while considerably in excess of those at 25 cycles, are considered quite normal for commercial purposes, and inasmuch as the increase and decrease in the load is gradual the regulation is well within control of the central station operators or automatic devices.

As to the railway load, this had better be carried on a separate circuit, whenever a multiplicity of circuits is used in transmitting the power. In our case there are three transmission circuits.

Considering the successful operation of one of the long-distance transmission lines of 150 miles in California, where the charging current forms 40 per cent of full-load current, and where the regulation is 40 per cent. at full load, 80 per cent. power factor, we need not hesitate to operate our line with a regulation of 23 per cent., 80 per cent. power factor.

The power factor of the system, however, is to a large extent within the control of the operating company, as it may recommend to power users such apparatus as will best answer the purposes of the system as a whole. Beside this, by employing synchronous motors running as rotary condensers, it will be enabled to regulate the power factor of the system and keep it if necessary at unity. These synchronous motors running idle, used supplementary to the synchronous motor-generator sets, will allow of a perfect control of the power factor of the system, reducing the regulation to 9 per cent. under full-load condition.

In conclusion, we will say that under the conditions as stated, for a mixed lighting and power load, with a railway load not exceeding 33 per cent. of the total output, a three-phase, 60-cycle system should be employed throughout and all transformation should be accomplished by delta to delta connection.

LIGHTING AND SUCTION GAS FOR POWER PURPOSES.

An abstract of a test carried out at Munich for the purpose of comparing ordinary lighting gas with suction gas is given in a recent number of "Elektrotechnik und Maschinenbau." The test was made on a 36-h. p. engine having a 250-mm. diameter cylinder and a 400-mm. stroke. The best results with lighting gas were obtained at a load of 35.9 i. h. p. (which was almost the maximum load), and showed that 42.7 per cent. of the available heat was converted into indicated horsepower, 33.2 per cent. was lost in the cooling water, whilst the remaining 24.1 per cent. was lost in the exhaust gases, etc. The average speed was 210.7 r. p. m., the average indicated cylinder pressure 114 lbs. per square inch the minimum, heat value of the gas was 500 B. Th. U. per cubic foot, and the hourly consumption 395 cubic feet (reduced to 0 deg. C. and 735.5 mm. pressure), giving a consumption of 11 cubic feet per indicated horsepower hour. The suction gas test was made at nearly the same load (34.9 i. h. p.). The speed was 210 r. p. m., the average cylinder pressure was 112 lbs. per square inch, the heat value of the anthracite used was 14,000 B. Th. U. per lb., and the consumption of anthracite per indicated horsepower hour was .75 lb. gross (including the heating-up and burning-out periods), or .63 lb. net, counting only the coal used whilst the engine was at work.—"Electrical Engineer" (London).

SOME POINTS ABOUT SINGLE-PHASE MOTORS.*

By W. Langdon-Davies and F. B. O. Hawes.

The title of this paper will, it is hoped, be sufficient to prevent you from anticipating more than some brief sketches of a few matters of interest relating to single-phase motors. The types of motors dealt with are those which are used on ordinary single-phase circuits, supplying current for lighting and power, and not with those for traction, etc., working on special low-periodicity circuits. The whole subject is full of interest, but only a small portion can be touched on in the scope of one paper.

One of the earliest, if not the earliest, motors run by a rotating field was that devised by Walter Bailey. In his arrangement the shifting of the magnetic axis of the field, commonly called the rotating field, was produced mechanically by means of a commutator, which, although attached to the rotor, really commutated the field and caused it to more or less rotate. Direct current was used. This machine is worthy of much the same admiration that one bestows on, say, "Puffing Billy," when one considers the difficulties which beset the early pioneers. The shifting of the magnetic axis can be produced by other than mechanical means.

Who was the actual first inventor of the commutatorless single-phase motor starting on split field and subsequently working on a single-phase impressed field is not certain. It was probably invented by more than one person practically at the same time. Professor Ferraris, in a lecture, demonstrated this method in March, 1888. At about that time Nikola Tesla obtained and held patents in America, England and elsewhere for producing the same results. Touching these early patents of alternating-current motors, there is one that will probably interest you—namely, that taken out by Dobrowolsky, dated December 15, 1890, for the introduction of resistance into the induced member, usually the rotor, at starting. This is of particular interest from a commercial point of view, as the patent was kept in force in England during its full time, expiring December, 1904. Although the owners of the patents appeared indifferent to their rights, English makers were restrained from making motors with slip rings. The patent was held by a foreign company.

The first experimental machine made by Mr. Langdon-Davies, which ran at all was constructed at the end of 1891. This was really a three-phase motor, the three phases being obtained from a single phase by splitting the phases, this being accomplished by inserting resistances in two of the circuits of the motor and no resistance in the third. The two resistances were, of course, of different values. The idea of phase-splitting was suggested by the results of some telegraph experiments. The stator and rotor were each ring-wound, and had polar projections, similar to the field magnet of a direct-current motor. No worse way of building an alternating current motor can be imagined, but if you remember that there was no common knowledge of the subject fifteen years ago you will realize that a pioneer had to discover these things for himself, and that his most useful discoveries arose from his mistakes.

The next machine—which was a two-phase motor—was wound with two separate windings on alternate poles for each phase. Two phases were obtained from a single-phase supply by the now common means of inserting a choke in one winding and a non-inductive resistance in the other. The rotor was a squirrel cage. The machine required a very large current to get it to start, and was very inefficient, and naturally had a very low power factor.

*Paper read before the Birmingham (England) and District Electric Club, Oct. 13, 1906.

Realizing that salient poles had serious disadvantages, the next machine was made with slotted tunnel windings with one pair of tunnels for each pole. There were two sets of poles wound with two separate windings, each winding being upon alternate poles. Both sets of poles and windings were used at starting; a variation of phase between the two sets was obtained, as before, by inserting a non-inductive resistance in the one set and a choke in the other. When the speed was nearly synchronous, one set of coils and the resistance and choke were cut out of the circuit and the machine ran as a single-phase motor. This machine, again, took a very large current at starting and was very inefficient.

It became apparent that the idea of having separate poles was a fundamental error. Separate poles may be considered as producing an effect on the rotor somewhat like that of a ratchet and toothed wheel, whereas what is required is a magnetic action upon the rotor which may be likened to the bristles of a brush continuously sweeping it round. The rotation of the rotor is produced by the field of the stator generating current in the rotor, which, again, produces a field reacting on that of the stator. When the rotor is revolving at nearly synchronous speed, the axis of its field should be as nearly as possible ninety degrees behind the axis of the stator field in the case of a two-pole machine. This can not be the case where there are separate poles, because there are points between the poles where the rotor has no effective return path. It was evident, therefore, that the whole of the interior surface of the stator must be magnetized both when running as well as when starting. In this motor such was not the case. In starting it will be seen that, when the alternate sets of poles were at zero they were inert, and when running, one set of poles was permanently inert.

This machine was rewound so that the starting and running coils each enclosed the whole magnetic circuit. By this arrangement both the magnetic fields of the rotor and stator when running, or the fields set up by the two windings when starting—to express the action in a very unorthodox manner—were better mixed together, and there was no position at any moment when the magnetic circuit of the rotor had no effective return path. This machine was a great improvement on its predecessors, and was the first machine which did really useful work. An important point to bear in mind as regards this machine was that every turn of the windings surrounded the whole of each of the poles. Consequently, owing to the varying reluctance, the field varied in density from a minimum at the center of a pole to a maximum on its edge, and a good rotating field could not be obtained. This motor had much to be desired in the way of efficiency. The next machine was built up of stampings having four slots per pole; this was a distinct advance on the previous machines. All these early efforts were made some fourteen years back. At the present date, thanks to the knowledge gained by the pioneers of the industry, the building of good single-phase motors is more a mechanical than an electrical problem.

Four properties are essential to a good single-phase motor—namely: (1) efficiency; (2) a high power-factor; (3) it should not overheat (though heating does not always indicate inefficiency); (4) it should be mechanically sound.

There are two other properties which are commercially useful, but have no other importance—a motor should be cheap and should look attractive. The last factor is a very variable one and we have not as yet found any reliable formula for it.

Dealing first with high power-factor. The power-factor of a motor matters but little to the consumer. He need not consider what current ebbs and flows through his meter, he only regards the watts the meter registers against him. Further, the additional amount of copper required adds nothing to his working costs, and but little to his capital

outlay. Up to a certain point, however, it does matter to the supply station inasmuch as it entails more loss on the conductors, or, to put it another way, more copper to supply the same power at a lower power-factor.

The efficiency of a motor is not essentially important to the supply companies, the more watts per horsepower it consumes the better in some ways for the supply company. We do not for a moment suggest that a supply company would, or, in our experience, ever has attempted to, get inefficient motors used by its consumers, but we do wish to impress upon you the relative values of power-factor to efficiency in a commercial sense.

The term power-factor is in itself misleading. It suggests to many people that a high power-factor means a high power of some kind, whereas what it really means is that a machine which is described as having a high power-factor is one which really requires a small magnetizing current, and for that reason we prefer to call the wattless current the magnetizing current. All motors require a magnetizing current, even direct-current motors, but the difference between the magnetizing current of a direct-current motor and that of an alternating-current motor is that in the direct-current motor the whole of the current is wattful, if we may use the word, whereas in alternating-current motors the bulk of the current is wattless. In the case of the direct-current motor, the whole of the magnetizing current is recorded in watts on the meter through which the motor takes its supply, whereas in the case of the alternating-current motor none of the really magnetizing current is recorded. The only portion of the alternating current which is recorded is that which either does useful work or is dissipated in hysteresis, mechanical friction, Foucault currents and copper losses. In the case of the direct-current motor, however, the magnetizing current may be very small, whereas in the alternate-current motor the magnetizing current must be comparatively large. The loss on the mains between the supply station and the meter is C^2R, therefore the smaller the current supplied to the motor for a given horsepower the cheaper the supply will be.

It is therefore advisable on general grounds to have as small a magnetizing current as possible. It is not a difficult thing to produce an efficient alternating-current motor, provided the amount of magnetizing current can be ignored. The chief losses are due to Foucault currents, hysteresis and C^2R in the copper. Good lamination of the magnetic circuit reduces the Foucault currents. Good quality of material reduces the hysteresis currents as well as the reluctance. Plenty of copper reduces the copper losses.

The third requirement is the one that gives the most trouble in construction, for the larger the amount of copper wound the more difficult it becomes to keep down the reluctance of the magnetic circuit and therefore keep down the magnetizing current.

There are three ways employed for getting the wire on to the iron: (1) Open slot winding (sometimes with former-wound coils); (2) tunnel winding; (3) combinations of the two.

Open slot winding decreases the area of the air-gap for a given diameter of rotor. Tunnel winding is apt to increase the magnetic leakage. Both of these increase the required magnetizing current in proportion to the power obtained, therefore various compromises are used.

The length of the air-gap is a most important factor in reducing the required magnetizing current. It can, in practice, be reduced to as little as 1-32 inch, but with so small an air gap as this the rotor must be very accurately centered. If it were 1-128 inch out of center, this would cause the length of the air?gap on one side of a diameter to be in proportion of three to five of the gap on the other side; a serious concentration of the field to one side of the rotor would result, thereby producing a considerable and useless side pull which would impair the starting qualities of the machine. This side pull is most serious in a two-pole machine.

Ordinary bearings soon wear to the extent of 1-128 inch, and the absolute necessity for some better bearing was demonstrated. The bearing which, in our opinion, best supplied the necessity was one constructed by our company, which was of highly-polished cast iron, a steel spindle being employed. The bearings were ring-lubricated and worked exceedingly well if kept properly lubricated and clean. For example, the company has now a six-brake-horsepower motor running in their works which has been going for ten years, and the bearings have never yet been touched. Unfortunately, these bearings had to be given up because it was found impossible to get the general user to attend sufficiently to the lubrication, especially in seeing that dirt was kept out of the oil. In the case of starting a new machine, it was absolutely necessary to see that the oil was working well through the bearings before running up to speed, as if they were dry it only took a fraction of a second for them ti seize.

There have been cases in which the users filled up the oil-box, which was fitted with a ring lubricator, with grease, and then switched on. The shaft seized, naturally, almost at once, and they could not be convinced that this was the result of their own neglect, but regarded the motor as a very bad machine electrically and mechanically. Good phosphor-bronze bearings have, however, been found to satisfy the general conditions.

Passing on to the consideration of rotor winding, it is absolutely necessary, in getting on the requisite amount of copper, to keep the area of the air-gap as small as possible. The earliest form of short-circuited induction rotors were wound (if it may be called winding) by thrusting a number of rods through poles in the rotor and soldering them to copper rings at the two extremities of the rotor; this was known as the squirrel-cage rotor. The holes in the rotor were placed as near the periphery as possible to avoid magnetic leakage.

Such a rotor may give trouble in construction, inasmuch as it is difficult to ensure that the copper squirrel cage is exactly concentric with the magnetic circuit of the rotor. Although the rotor might be mechanically balanced, it is possible for there to be a squirrel cage of copper inductors moving eccentrically to the field, which will produce starting difficulties. If the rotor is wound either with copper rods or bars in open slots, troubles arising from eccentricity of the copper produce little or no effect. After some years of experience and experiment my company has adopted for its short-circuited rotors a form of open slot winding. The slots can hardly be called slots, they are more of the nature of saw cuts, which are filled with copper strip. By this form of construction sufficient copper is put upon the rotor and a large area of air-gap maintained.

Passing on to the third property that a motor should possess—namely, that it should not overheat—you will remember that we said this did not always indicate inefficiency. This can be readily understood if you consider that if a well-designed motor which ventilated itself were shut up in a box it would soon overheat. The question of heating is one that requires careful consideration. If the efficiency is not affected it does not really matter how hot a motor gets, unless its temperature is such as to cause damage to itself or its surroundings. For instance, picture a 100-brake-horsepower motor of ninety-five per cent. efficiency. The remaining five per cent. or five brake-horsepower, whatever way you like to take it, has to be dispersed in heat, and it is essential that this heat should not produce in any part of the motor such a temperature as to become destructive to the insulation or any other part of the machine; but it should be understood that, provided the temperature of a motor is not sufficiently high to be either destructive to the machine or its surroundings, its actual thermometric measure does not matter.

This brings us to the question of ventilation, which is a most important one, and we venture to say much more difficult in an alternating than in a direct-current motor. The ventilating spaces between the pole pieces do not exist in an alternating-current motor, and as the stator has to completely surround the rotor there are no spaces for the air to circulate in. It will be seen from the rotor on the table that a circulation of air is produced by providing the rotor with blades. These throw the air out from the center and are shaped so that the same effect is produced whichever is the direction of rotation of the rotor.

So far, we have only considered short-circuited rotors. These, of course, have a comparatively small starting torque per ampere. It should be remembered that it is only the starting torque per ampere that is of importance. An ordinary squirrel-cage rotor can be made to give a large starting torque if the stator is so wound as to give it a large current.

The efficiency of a motor when running up to speed is also a point worthy of careful consideration. In such cases as cranes and lifts, where the motor is practically always starting, it is especially important that it should be efficient when running up to speed. This is not so, however, when a motor is used to drive the shafting in a factory, and is only started up, say, twice a day, the time of getting into speed being a minute fraction of the total time the motor is in action.

A larger starting torque is obtained per ampere where the rotor has slip rings and a resistance is introduced into the rotor circuit. This, however, introduces complications. H. M. Hobart, in his book on electric motors, admirably sums up the case. He "would employ the squirrel-cage type of motor much more generally as having such great advantages on the score of simplicity, robustness, better economy in operation, and cheapness in manufacture, as to justify its use, not only in very small sizes, which is the present practice, but also in practically any size, in fact, limiting the use of slip-ring motors to special cases. It is true that squirrel-cage rotors must be started with little or no load, and even then must be started from a compensator, in order to limit the starting current to a permissible amount, but by the use of mechanical devices designed to apply the load after starting, they are made not only equal to, but more satisfactory than, the slip-ring motor, being characterized by higher efficiency, power-factor and overload capacity, and requiring a minimum of attention. The slip-ring motor, on the other hand, is not only less satisfactory with respect to these constants, but it is inherently more expensive, more liable to break down, gives at the slip rings and brushes practically as much trouble as a commutator, and must have troublesome and expensive auxiliary attachments for internally short-circuiting the slip rings and raising the brushes after starting. All these disadvantages are encountered simply in order to obtain improved starting."

So far we have chiefly discussed some mechanical points about a single-phase motor, but the question of starting at once brings us to the unseen, and, we venture to say, the most important, consideration—viz., the rotating field by which the motor is started. Supposing a rotating field to be set up in the motor, in order to obtain the best results its speed of rotation should be perfectly constant, and it should not vary in strength during each revolution. This result is practically unobtainable in a split-phase motor, as certain compromises have to be made. For example, take the case of a two-pole machine, and consider what is really required to produce a rotating field. The field should be perfectly uniform in density all round the air-gap. This in itself is a difficult condition of affairs to produce in practice. Since tunnels of some kind must be used to contain the stator winding, it is obvious that the reluctance across every diameter of the air-gap is not uniform, and therefore the magnetic field in the air-gap cannot be uniform. Any want of uniformity in the rotating field produces wasteful currents in the rotor. Modern methods have, however, reduced these irregularities by careful design.

There is, or was, one difficulty in getting single-phase motors to start which we think will interest you, although with modern alternators it is a thing of the past. We refer to the wave shape of the alternating current supplied to the motor. Some of the most astonishing results may arise from irregular wave shapes—viz., those which are not sinusoidal. For instance, with a double-crested wave, a condition which frequently used to occur in practice, the resultant magnetic field would not only cease to revolve, but twice in a revolution it turned back against the direction of rotation of the rotor. It is obvious that under such conditions there will be great difficulty in getting the rotor to run up to speed.

The whole of this subject is so extensive that it is impossible to know when to stop, but it is hoped that the above points will be of some interest.

VOLATILIZATION OF METALS.

The results of experiments to volatilize the metals belonging to the platinum group by means of the electric furnace were recently detailed before the Academie des Sciences by M. Henri Moissan. Melting took place readily with all these metals when a current of 500 to 700 amperes at 110 volts was used. With 500 amperes of current, 150 gm. of platinum reached the melting stage in one or two minutes, and four minutes later that of evaporation. Ruthenium, palladium, iridium and rhodium were evaporated with the same amount of current, but osmium required 700 amperes. The distilled metal resulting from the treatment of the same weight of metal in each case (150 gm.) was as follows: Osmium, 29 gm.; ruthenium, 10 gm.; platinum, 12 gm.; palladium, 9.6 gm.; iridium, 9 gm.; and rhodium, 10.20 gm.—Electrical Review (London).

SAN DIEGO MEETING OF THE CALIFORNIA PROMOTION COMMITTEE.

The most important meeting ever held by the Counties Committee of The California Promotion Committee, so far as results beneficial to the State are concerned, was that held in San Diego on Dec. 15th, in which representatives of fifty-one of the fifty-seven counties of the State participated. At this meeting papers were read which put forth the needs of all the harbors of California, and also the interdependence between the harbors and the various industries of the State. As the meeting was that of a State organization, no attempt was made to devote attention to individual interests of the harbors, but it was the opinion of the delegates that all efforts should be centered upon work that would improve all the harbors of California, as in this way the whole State would be benefited by the work of the committee.

Resolutions were passed requesting Congress and the Governor of California to appoint commissions who will examine into the needs of the harbors of this State and recommend such improvements as are deemed desirable. The Legislature is asked to enact laws and vote the appropriations necessary to put these recommendations into effect.

It was decided to call a meeting of the Advisory Committee to be held in Sacramento on Jan. 11th.

At the meeting of the Joint Committee of the Electrical Development Association, held in New York on December 13th, a resolution was passed expressing confidence in the program outlined for the future development of the association. Three committees of five members each were appointed to make a report on the following respective subjects: Constitution and by-laws; membership assessments; commercial program. The association hopes to effect a final organization at its next meeting.

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EDITORIAL.

San Francisco is busy. We may not have all the material comforts with which we were surrounded at this time last year, but, while we thought then we had all we possibly could do, we really did not know what it is to work every hour in the day, and as a result, have the pleasure of seeing our efforts quickly materialize in a concrete result.

San Francisco's New Year

To the engineer, no place in America can be of equal interest with San Francisco today. No one appreciates better than the engineer how much to be preferred it is to begin entirely new as compared with the attempt to repair or alter or enlarge an old obsolete installation or structure. San Francisco has begun with a clean sheet, not to mention the work of clearing up the debris resulting from three days' destruction, and for modern, up-to-date construction of the highest class, this city will eventually be among the best in America.

It is not to be supposed, however, that this can be accomplished in a few months or a year, but it is being done day by day most consistently, and the beginning of the year 1907 witnesses the work well under way.

It is marvelous when one considers the extent of the reconstruction done and the results accomplished by the electric light, and power, gas, street railway and telephone companies. It is not as if each or any of these public utility corporations were able to immediately proceed with their new construction, but from the very first, business greater than ever before had to be carried on at the same time the new construction was being prosecuted. Nor was there a moment's delay. No one even queried whether the restoration of all such public service was to proceed or not. It was taken for granted from the very beginning that these installations were not only to be rebuilt, but the new plants were to be better than ever before.

San Francisco occupies a unique position among the cities of America. Its location, geographically, marks its essentially as a commercial city. Today more business is being done than ever before in its history, and probably more than one-half of its business is being done in temporary buildings, but the modern sky-scrapers are also being rushed to completion. It is said that, for the most part, the necessary money is coming primarily from San Francisco and California to rebuild the city. While this may be true from the standpoint of the new buildings, it is not the case with the reconstruction of the gas, electric light and power, street railway and telephone companies. These public utility corporations are largely controlled in the East, and it is with gratitude that the San Francisco people have witnessed the unlimited support these eastern interests have given to the local managers in reconstructing their damaged plants.

Due to the great industrial development of the past ten years, particularly for the use of the transportation, electric light, power and gas interests, San Francisco today has cheaper fuel and cheaper power, and at the same time is very largely independent of the supply of coal which up to within the last few years has always come to San Francisco from outside of the United States. Fuel oil for the generation of steam power has practically entirely replaced coal, and the extensive development of electric power transmission from the mountains has made it possible for San Francisco, and in fact all California, to get a large part of the required power, independent of coal as fuel, which has always been expensive in addition to being limited in quantity. San Francisco's predicament at the present time from the power and fuel standpoint can be easily imagined, if with the present serious shortage of coal the entire city and its power and light plants were dependent upon such supply of coal. Fortunately, the oil fuel supply and electric power transmission has solved this problem, it is to be hoped, for all time.

San Francisco looks forward to a most prosperous New Year. The co-operation of all interests should make Nineteen Hundred and Seven the greatest year in the history, not only of the City of San Francisco, but the entire Pacific Coast.

TRADE CATALOGUES.

The Electric Storage Battery Company, of Philadelphia, has recently issued a folder describing the application of "Chloride Accumulators" and Exide Batteries to railway signal and interlocking systems. The folder contains an interesting table showing the rapid increase in the use of these batteries for this class of work, and gives illustrations of several of the types usually employed in signal service. Illustrations are also shown of batteries of "Chloride Accumulators" in place in semaphore towers.

The Chase-Shawmut Company, Newburyport, Mass., is now sending out its latest bulletin, No. 36, in which is listed the full line of fuses and fuse fittings manufactured by this company. These include the N. E. code enclosed fuses of carrying capacities up to 600 amperes, porcelain single pole bases especially for 30 and 60 amperes on 250 and 600-volt circuits, double and triple pole cutouts, special contacts, etc. The "Shawmut" extended terminal enclosed fuse is a new product popular with the jobbers, and fits any type A block of Noark, D. & W. or Shawmut manufacture. The bulletin is amply illustrated.

Crushing machinery for breaking up coal, rock salt, phosphate rock, etc., is rapidly coming into extensive use in many industries. The Allis-Chalmers Company describe in Bulletin 1419 several patterns of this class of machinery. The difference lies mostly in the character of the rolls, which is determined by the hardness of the material and ultimate size required. Removable steel teeth are usually recommended, though teeth cast on segments for bolting to the rolls are also made.

Bulletin 1501 of the Allis-Chalmers Company is devoted to belted Corliss engines of the "Reliance" pattern. Though the first Reliance engine was built less than three years ago, an unusually large number of them are already in operation, giving great satisfaction. These engines are of the high speed type and occupy less floor space than is required by engines constructed according to the usual Corliss practice. There are many half tones to illustrate the most important constructive features.

The Allis-Chalmers Company has also issued a leaflet giving the principal products manufactured, the various works owned, and the many district offices which this company has established all over the world.

Some recent publications of the Allis-Chalmers Company, Milwaukee, Wis.:

Bulletin No. 1503. Here is given a description of the Reynolds-Corliss engines built by the Allis-Chalmers Company for driving electrical and other fast running machinery by direct connection or belting. These engines are of the "Reliance" pattern.

Bulletin No. 1510. This is devoted to Reynolds-Corliss engines of the heavy duty pattern. They are made either horizontal or vertical or combined, simple or compound, condensing or non-condensing, and for triple expansion.

Folder No. 4001. This describes the Reliance friction clutch. These clutches are built in sizes for loads ranging from 8 to 425 horsepower at 100 revolutions per minute.

PERSONAL.

Mr. Rudolph W. Van Norden, consulting engineer, who has had offices in Oakland since the fire, has again established himself in San Francisco in the Mutual Savings Bank building.

Mr. E. Dewald, manager for the Platt Iron Works, left for the East on Friday, January 4th.

FOR THE STUDENT.

All things are more or less hard to do, and only work will do them. Get a right idea of work. Don't trust to cleverness. It is worthy, but it will not do your work. Accomplishment demands singleness of purpose and concentration. All exterior forces tend to diversion from these essentials. Here you come in again to show your triumph of personality over environment. No matter what you do, from the humblest incidental thing of the moment to the consummation of your greatest ambition, the same principles of human activity apply. All will be clear sailing until you meet resistance, and sometimes you will run against it hard. Then you will find whether you have nerve or nerves. No one can help you much. Your measure is being taken, and you win or lose upon the cumulative ability which you can muster as the total assemblage of native talent and all that has become a part of you through all the influences that ever entered your life. See to it that they all shape one way. You will meet some disappointments through your own faults and some because the world is not exactly just, but whoever gets approximate justice in the world is doing very well. The perfectionist has a hard time. He meets continual disappointment, especially if he is chiefly worried about the imperfections of others.—Mr. W. C. Kerr, before the students of the Staten Island Academy.

TELEPHONING ACROSS THE MISSOURI.

Owing to the constantly changing bottom of the Missouri River a cable is not considered practical and the telephone wires connecting Council Bluffs and Omaha are suspended from a steel tower on each bank, 110 feet high. These towers are built of galvanized iron and each will sustain a strain of 20 tons. The guy ropes are carried back 700 feet and anchored to heavy concrete blocks.—"Popular Mechanics."

GAS EXPLOSIONS.

In his address before the Michigan Gas Association, Mr. W. H. Barthold pointed out that a large number of disastrous accidents occurred during the past year from gas explosions. They have not only destroyed portions of plant, but caused loss of life. "We boast," said Mr. Barthold, "of the progress we are making in all branches of the gas business, but the increasing number of accidents indicates that some companies are not improving in one respect—that is, in discipline among their men. The fault lies in the management. Some gas managers neglect to issue and enforce instructions to their employees, that are necessary to make our business a safe one. Employees in all departments should be taught to use extreme care and judgment in the performance of their duties. This can only be done by enforcing proper instructions for their guidance."

TROLLEY-HOLDING DEVICE.

James O'Neill, a locomotive engineer for the Spokane Falls & Northern Railway, has invented a device to prevent street car trolleys slipping from the overhead wires. It has been tested on Spokane lines and found to be satisfactory. The device consists of two clamps adjusted to the pinion of the trolley wheel. The ends of the clamps lap over the ridge of the wheel and form a shoulder, against which the wire butts whenever the pole becomes unsteady.

HYDRO-ELECTRIC PLANT EFFICIENCY.

The efficiency of an hydro-electric plant may be diminished as much as 30 per cent. by flood water, and again at low water the efficiency of such a plant suffers in spite of modern improvements. It would seem, however, that Marc Sangey, manager of the power station at Chevres, near Geneva, has hit upon a practical remedy for the first-mentioned trouble. His method consists in constructing two sluice gates in the foot of the weir. At flood times the large volume of water discharged through these sluices produces an ejector effect, whereby the water-level in that part of the tail race between the two sluices is lowered, and the turbine receives the benefit thus obtained. Experiments have proved that the ejector action or suction caused by the outflow from these sluices at high water is sufficient to maintain the water-level within the influenced area constant. Thus, instead of being allowed to flow aimlessly over the weir, the excess water in times of flood is used to counteract the drop in output which would otherwise ensue. At low water the sluice gates are kept closed, and all the head water then flows through the turbines in the ordinary way. The first practical experiments were made at the power station in Chevres. In this case the weir was provided with six underwater sluices. Between the third and the fifth of these, in front of the fourth closed sluice, the turbine was erected to receive the head water. At high water sluices 3 and 5 were opened wide, and caused by their ejector action a lowering of the water-level, as described, within the area of the tail races bounded by the two discharges. The natural head of water at the turbine was compared with the head thus obtained. It was found that the normal head was 4.96m., whereas with the underwater sluices 3 and 5 fully open, the head was increased to 5.80m. by the lowering of the level in the tail race—again of 1.11m. The turbine, which at high water gave an output of 1,233 horsepower with a volume of water of 26.6 cubic metres per second and the ejector sluices closed, proved capable with these sluices open of giving a maximum output of 1,543 horsepower, representing an increased efficiency of 23.6 per cent. The ejector sluices, it should be mentioned, discharged a volume of 205 cubic metres of water per second. Further experiments with a much lower head (1.7m. to 1.8m.) were made at the Vessy sur l'Arve power station, where a 1,200-horsepower turbine was similarly erected. In this case the turbine yielded an output of only 960 horsepower at high water with the ejector sluices closed, but gave its full output when they were open. It follows from these results that ejector sluices for the purpose in question, having a capacity of 150 to 200 cubic meters per second, are capable of counteracting the lost efficiency due to high water in a hydro-electric plant utilizing the natural fall of a river through the medium of a head-race and weir. A full account of these interesting experiments was published in the "Bulletin Technique de la Suisse Romande," issues 3 and 6, 1906.—"The Electrical Engineer" (London).

ADVANTAGE OF ROTARY CONVERTERS.

In a paper read before the British Institution of Electrical Engineers, Mr. Miles Walker said that it is not true that the motor-converter has all the advantages of a motor-generator, and as high an efficiency as the rotary. In comparing the efficiencies of different machines, it is very important to consider the basis of their ratings. When a substation is supplying a town load, it is always necessary to have enough machines running to avoid catastrophe in the case of sudden unexpected demands. The efficiency of the substation will greatly depend upon how many machines are running, and how near to full load they are working. If the station is provided with rotary converters, it is in most cases perfectly safe to have all the rotary converters fully loaded and allow them to be overloaded before a new machine is thrown in. When dealing with motor-converters or motor-generators, which are not able to take such excessive overloads without danger, the station engineer is not justified in normally running his machines up to such a high point. He must, except for the very steadiest loads, always have some capacity in hand to meet sudden demands and give him time to throw in other machines.

FIRST INTERNATIONAL EXPOSITION OF SAFETY DEVICES.

Space is now being assigned for the exhibits at the First International Exposition of Safety Devices, to be held in New York at the American Museum of Natural History beginning January 29, 1907, and continuing two weeks. Safety devices will be exhibited applicable to machinery used in various industries and in railway operation as well as for protection from fire. Since the object of this exposition is to awaken the American public to the necessity of doing something to lessen the accidents to life and labor, by means of a permanent museum of safety devices where all problems of safe-guarding life and limb can be studied in their working details, there will be no charge for space. It is earnestly desired that all those wishing to exhibit should apply without delay to the Director, W. H. Tolman, 287 Fourth Ave., New York.

IMPROVEMENT OF RIVERS AND HARBORS.

P. J. van Loben Sels, who attended the National Rivers and Harbors Congress held in Washington, D. C., in December, as a delegate from the River Improvement and Drainage Association of California, gives many important facts in his report to Rufus P. Jennings, President of the Association, regarding the meeting and the work that was done looking toward the betterment of conditions in California. Mr. van Loben Sels was requested by President Roosevelt to make known his ideas in writing relating to the proper methods of looking after the harbors and rivers of the country. The President promised to take the matter up with his cabinet.

Secretary of War Taft was especially interested in the work on the Pacific Coast, and had a long conversation with Mr. van Loben Sels regarding what was being done. In the Congress the resolutions adopted were confined entirely to the idea of having an annual appropriation of $50,000,000 made for the betterment of the waterways of the nation, as it was believed that such a policy would be far better than the old method of having the work parcelled out according to the influence of legislators from various sections.

It was along these same lines that the Counties Committee of the California Promotion Committee, at its recent meeting in San Diego, worked, believing that the ideas of a body of men like that assembled in Washington represented the consensus of opinion of those who had made a continuous study of the improvements of water ways.

In closing his report, Mr. van Loben Sels expresses himself as well pleased with the results obtained from the Congress, and says he thinks much good will come from the work done.

THE INSTALLATION OF ALTERNATING-CURRENT GENERATORS.

Engineers in charge of power stations and students of electrical engineering will no doubt be interested in the methods for installing alternating-current generators which are recommended and practiced by the Allis-Chalmers Company.

All of the generators built by this company belong to the revolving-field class, the armatures being fastened to the stationary frame. They are made in five types designated as "belted," "water-wheel," "engine," "fly-wheel," and "turbo," the last named being for direct-connection to steam turbines.

The mechanical construction varies to some extent with the size and type of generator, so that it is not practicable to give a description that will apply to all of these machines. In most cases, however, the general arrangement is as shown in Fig. 1. The manner of arranging the coils and interconnecting them varies with the number of phases for which the machine is built, the voltage, and other factors. Fig. 2 shows a portion of the winding for a three-phase machine with coils arranged the same as in Fig. 1. For lower voltage machines where it is not necessary to have such high insulation, the winding is frequently of the type shown in Fig. 3. All the coils are of the same shape and each side occupies only half a slot, one side lying in the upper part of one slot and the other occupying the lower part of another slot. The

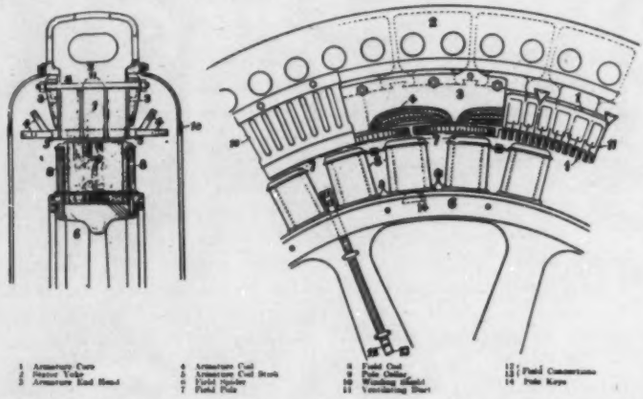
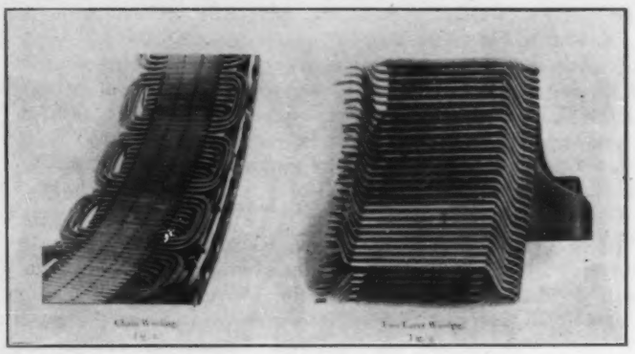


FIG. 1. CONSTRUCTION DETAILS OF AN ALTERNATING GENERATOR.

field coils of all except some of the smaller machines consist of bare copper strips wound on edge, with adjacent turns separated by tough insulating paper. In many small machines it is necessary to wind the field coils with square copper wire in order to admit of excitation at 120 volts.

The location of the generator is usually fixed beforehand by the position it must occupy relative to the engine or shafting. There is, therefore, little choice as to this, but it is always desirable to install alternators, or in fact any electrical machinery, in a clean, dry place where there will be plenty of light and room. Good ventilation is important, since the better the ventilation the lower will be the operating temperatures of the machine. There should not be any combustible material near the alternator and the location should provide for sufficent head room to permit taking the machine apart if necessary.

The foundation on which an alternator rests should be firm and substantial, in order to prevent vibration and secure smooth running. Small belted machines below 100 kilowatts can, if necessary, be set on heavy timber supports, but a concrete or brick foundation is preferable. All machines above 100 kilowatts should be provided with concrete, brick or masonry foundation, concrete being the most suitable. A satisfactory concrete for this purpose can be made of two



ALTERNATOR ARMATURE WINDINGS.

parts of sharp sand, four to five parts of broken stone and one part of Portland cement, all parts being by bulk.

The foundation should be heavy enough to secure freedom from vibration, and, in building it, provision should be made for foundation bolts to hold down the base, rails, or sole plates of the machines. In making the foundation, iron pipes should be placed in the approximate locations that the foundation bolts will occupy, using pipe having an inside diameter at least two inches larger than the foundation bolts, to allow adjustment. Pockets should also be arranged in the foundation to give access to the anchor plates and bottom nuts on the foundation bolts. After the alternator has been permanently located, thin cement should be run into the pipes, thus fixing the bolts accurately in position. Foundation bolts should be located by templates made from outline prints of the machine. The top of the foundation should be leveled off as accurately as possible and the cement allowed sufficient time to set before the machine is placed in position.

The National Board of Fire Underwriters favors the insulation of generators from the ground wherever it is feasible. Such insulation is generally provided by a substantial wooden frame or wooden stringers under the rails, the wood being well filled and varnished to prevent absorption of moisture. This is practicable with small belted generators, but with heavy machines or those direct connected to steam engines or water-wheels complete insulation from the ground is practically impossible; and it is better to connect the frame to the earth by means of a heavy copper wire connecting with a water pipe or other convenient ground. The frame of a machine should either be thoroughly insulated or thoroughly grounded so that there will be no doubt about its condition.

With belted machines, static electricity is frequently generated by the belt, thus charging the frame of the machine if the latter is thoroughly insulated from the ground. This

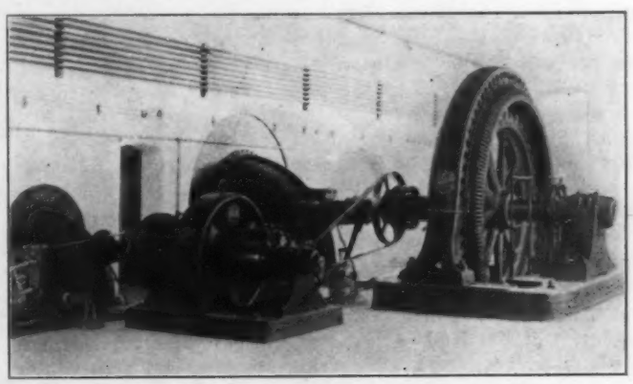


FIG. 4. ALTERNATING CURRENT GENERATOR, WATER WHEEL TYPE.

static electricty is generally removed by arranging a comb or a series of metal points close under the belt and grounding them.

The generators should be thoroughly protected against lightning and high potentials due to static electricity. The lines should be equipped with lightning arresters and, in cases where high potential static electricity is liable to accumulate, dischargers should be provided to carry it off.

Setting Up Belted Machines.

The rails should be placed in position, approximately leveled, and wedged up so that the weight of the machine will be distributed evenly. If the alternator is small and comes completely assembled, it can now be set on the rails, carefully leveled, and lined up with the driving pulley. If,

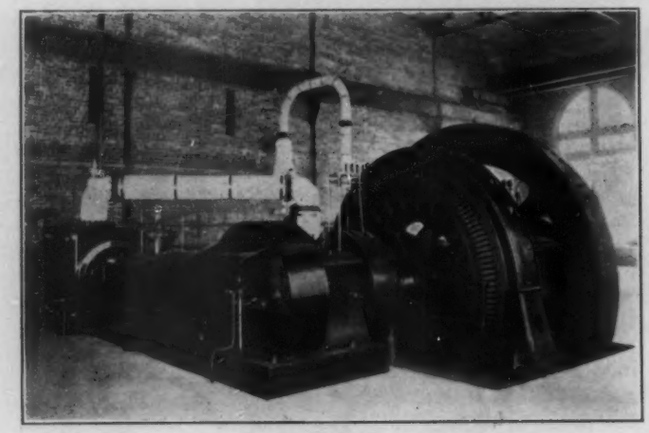


FIG. 5. ALTERNATING CURRENT GENERATOR DIRECT-CONNECTED TO A CROSS-COMPOUND HEAVY DUTY ENGINE.

however, the machine is of large size and shipped in two or more parts, the base is placed on the rails and the stator set in position, first making sure that the planed surfaces on the base and feet of stator are perfectly clean and oiled to prevent rust. Most of the larger belted machines are arranged so that the stator can be shifted to one side to give access to the field and armature coils, and when the stator is first set on the base it is advisable to locate it so that it will be to one side of the field when the latter is in position. All bearing surfaces should be well cleaned before the shaft is placed in the bearings; if there are any rough or rusty spots on the journals, they should be removed with crocus cloth. After the oil wells are inspected to see that they are thoroughly clean, the rotor is placed in position and the oil rings carefully watched to see that they do not get jammed and bent out of shape. When the rotor has been placed, the caps of the bearing pedestals are put in position and bolted down firmly. The stator can now be slid into place over the rotor and also bolted. If there are any dowel pins in the feet of the stator, they should be in position before the cap bolts are screwed down. The bearings are next filled with a good quality of mineral oil to the proper height as indicated by the oil gauge.

The pulley is now keyed to the shaft, and the whole machine lined up with the driving pulley. If possible, the machine should be run with a rather slack belt while the alignment is adjusted until the belt runs on the center of the pulley and allows the rotor to oscillate freely in its bearings.

Finally the foundation bolts are tightened down and the rails "grouted" by making a thin, easy-flowing mixture of one part of Portland cement and one part of sand, together with sufficient water, and pouring it under and around the rails. Small clay dams can be used to keep the thin cement in place until it hardens. When the cement is partly set the surplus can be removed and the joint under the rails smoothed up.

Water-wheel Type Machines.

The foregoing directions regarding belted machines apply for the most part to water-wheel alternators also, except that the latter have no rails, and the base is set directly on the foundation. In this case the machine must be lined up accurately with reference to the water-wheel so that the halves of the flange coupling will fit exactly. After lining up by means of wedges under the base, the foundation bolts should be tightened and the base well grouted in. Plenty of wedges should be placed under both inside and outside edges of the base so as to give a firm and even support. In some cases where water-wheel alternators are of large diameter and run at low speed, no base is provided. The stator and bearing pedestals rest on sole plates bolted to the foundation in the same manner as will be described for engine-type alternators.

Engine-type Machines.

With engine-type alternators the stator yoke either rests on an extension of the engine bed, as with some of the smaller machines coupled to high-speed engines, or on sole plates set on suitable foundations. The stator sole plates are made in two parts, the lower one being bolted to the foundation, while the upper plate is adjustable to facilitate centering the stator with respect to the field. To set up the machine, proceed as follows:

Locate the sole plates temporarily in position and support them on iron wedges to allow for further adjustment. Place the lower half of the stator in position and level it approximately by means of the leveling screws in the upper part of the sole plate. In case the stator is arranged to shift sideways on the base or sole plates, set the stator to one side so that it will be away from the rotor when the latter is placed in position. Locate the revolving field and engine shaft in the bearings, observing the same precautions given under belted machines. In case the engine shaft has not been pressed into the rotor spider at the factory, and it is necessary to do this work on the ground, special instructions should be sent, and the work done by an expert machinist.

Place the top half of the yoke in position, first making sure that all planed surfaces are perfectly clean. Carefully center the stator with respect to the field by means of the adjusting screws in the feet and sole plates, and measure the air-gap between stator face and sole pieces at a number of points around the circumference; it is very important to have the air-gap uniform, as otherwise the frame will be subjected to an unbalanced magnetic pull causing bad operation.

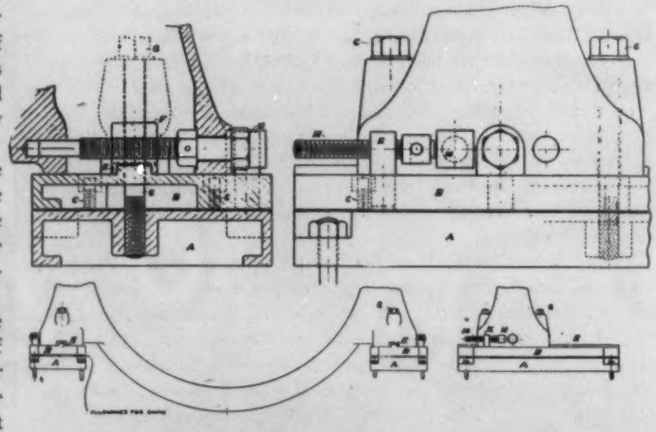


FIG. 6. ADJUSTABLE SOLE PLATE OF ALTERNATOR.

In large water-wheel and engine-type alternators where the stator is split, it is usually necessary for convenience in shipping, to disconnect and remove a few of the stator coils at the two partings in the frame. These must be carefully put in place and properly connected according to the instructions furnished with the generator. The coils must not be bruised and all connections should be neatly made and insulated to correspond with those for the other coils.

In aligning the yoke see that the center of the armature laminations is in line with the center of the pole laminations; if they are not in line there will be a side thrust on the shaft.

After the yoke has been finally adjusted insert shims between the upper and lower parts of sole plates so as to take the weight off the leveling screws. Drill and tap holes in the lower sole-plate to receive the holding-down bolts for the stator, and bolt the latter securely in place. Fig. 6 shows the construction of an adjustable sole-plate. A is the lower plate bolted to the foundation, B is the upper adjustable plate, CC are the leveling screws. The yoke is held in line by spline E; and by means of a bolt threaded into block F the yoke can be shifted in a direction at right angles to the shaft. For sliding the yoke sideways along the sole-plate, a jack screw H turns in nut K and bears against a plug M, which fits into a hole in the stator foot. Parts H, K and M are removed after the stator has been shifted to its final position.

Next grout in the sole-plates, and after the cement has set, tighten the foundation bolts and carefully check over the alignment of the machine. If at any time the engine bearings are adjusted or realigned the air-gap between stator and rotor should also be checked over and the stator again lined up, otherwise an uneven air-gap will result or the rotor may even rub on the stator.

With small alternators the collector rings are mounted in place on the shaft and connected to the field windings, while on large machines, especially of the engine-type where there is no shaft, the rings are shipped separately. In large machines both hub and rings are split so that they can be put in place after the rotor has been mounted in its bearings. The collector rings are fixed securely in position so as to run true, and the rings connected to leads from the field winding, making sure that all contacts are clean and tight.

With large engine-type alternators and also with some of the larger water-wheel machines, the brush holders are supported by a stand bolted to the base or to a bridge fastened to the sole-plates. On smaller machines the brush holder studs are supported by the bearing pedestals. All insulating bushings and washers on the brush studs should be looked over and the studs examined to see if they are bolted up tight. The brush holder stand, if there is one, should be firmly bolted to the bed or bridge and properly aligned with reference to the collector rings.

The brushes should be carefully fitted to the collector rings first by using coarse sand or garnet paper, and then by finishing with fine sandpaper. While shaping the brushes hold the paper well down on the rings so as not to wear away the edge of the brush. See that the whole surface of the brush makes contact with the ring and that the finger presses squarely on the brush. The pressure should be adjusted by changing the position of the tension spring on the arm, and should be such as to give a good contact on the ring; a greater pressure improves the contact very little and only causes excessive friction loss, wear, and heating of the brushes and rings. Good judgment and careful attention will soon show the best pressure to be used.

After the oil wells are filled to the proper height, the covers should be put in place so that no sand or dust can get into the bearings. When the machine is first started it is advisable to draw off the oil at the end of each day's run and fill up with fresh oil until it is certain that all fine particles of foreign matter have been removed. The oil drawn off can be filtered and used over again. When a machine is first started, it is well to run it slowly for about an hour and watch the bearings closely before bringing it up to full speed.

In all wiring, special attention should be paid to the mechanical execution of the work as extra precautions are necessary when wiring for high pressure alternators. The requirements of the National Board of Fire Underwriters should be carefully fulfilled, and care taken that all joints are secure and thoroughly insulated. All wires should be of sufficient cross section to carry at least 25 per cent overload without over-heating. For wires larger than Nos. 2, B. & S., it is advisable to use stranded cable, as this is much easier to run than solid wire.

DANGER OF POISONING FROM SUCTION GAS.

Captain Sankey, who copiled the report on tests of suction gas plants carried out by the Royal Agricultural Society of England, stated that the chances of poisoning were carefully considered, since the gas produced contains a large amount of carbonic oxide, which is of a very poisonous nature, and being inorodorus may easily escape detection. When an engine is working the pressure in the producer is below that of the atmosphere, and therefore any leakage would be into the producer. Hence the only real danger is when the producer is being started or opened up after running, and an accident can only occur through gross carelessness. When the producer is being started there is a pressure in it due to the fan; and to reduce the effort of blowing, and get rid of the air in the pipes, etc., a large vent pipe is opened by means of a valve. The outlet of this pipe should be carried outside the building where the discharge of gas can do no harm.

THE ARTIFICIAL DISPERSION OF FOGS BY ELECTRICITY.

The problem of artificially dispersing fogs has been studied by Maurice Dibos for some years past. As long ago as 1899 he endeavored to accomplish this by means of compressed air discharged from the bow of a steamer. Still later he took up the electrical method, using both alternating and direct currents, and succeeded in clearing zones from 100 to 150 metres in diameter. As soon as the discharge was stopped the fog at once closed in again, but dispersed upon renewing the discharges. Although what has been done in this direction is small, it points to possible important developments which would be particularly valuable in important commercial points. The article gives a review of all the work that has been done upon this problem, and gives some data showing the amount and kind of solid matter found in the air of certain large cities.—Abstract from "L'Electricien," by the "Electrical Review," (N. Y.)

WIRELESS TELEPHONY.

A practical test of wireless telephony was made recently at Cologne. The receiving apparatus was placed close to the bank of the Rhine, and messages were transmitted across the stream, it is said, with success. The transmitting and speaking apparatus, with a battery of 20 cells, was connected with a copper wire, the end—attached to a zinc plate—being sunk to the bed of the river. The Rhine served as the conductor, and the receiving device reproduced the sounds, enabling persons to converse with others on the opposite bank of the stream. Experiments were made over a distance of three miles, and while sounds were received from a greater distance, it was not possible to distinguish the words clearly. It is believed that wireless telephony will be of great use for shipping and harbor traffic.—"The Electrical Magazine."

AUXILIARY STEAM PLANT OF THE MOUNT WHITNEY POWER COMPANY.

In the Fall of 1905 the Mount Whitney Power Company decided to build an auxiliary plant near the city of Visalia to be run in conjunction with the water power plant already in operation. A careful investigation was made of the relative merits, costs and economies of gas engine, steam engine and steam turbine power plants, and resulted in the selection of the steam-turbine as the prime mover best suited to the local conditions. The new plant is situated just beyond the city limits. A spur track of the Southern Pacific Railroad runs through the property, and, therefore, it was possible to deliver the machinery without additional hauling. Fuel oil cars will be switched on this siding, which can accommodate six cars at one time.

The main unit consists of a Westinghouse-Parsons 1,000 kilowatt steam turbine, direct connected to a three-phase, 60-cycle, 2,300-volt generator, which has a continuous overload capacity of 25 per cent. The foundation for the turbine is made up of two parallel concrete walls spanned across the top by suitable I-beams. Between these I-beams and the turbine bedplate, there is a layer of lead about one inch thick. Since the centre of gravity of the Westinghouse-Parsons turbine is low, and there are no reciprocating parts, no foundation bolts are required.

The exciter set consists of a 17½-kilowatt Westinghouse, 125-volt engine type generator, direct connected to an Ohmen vertical engine. The switchboard is divided into generator, exciter, totalizing, transformer, and distributing panels. All main switches and bus bars are beneath the turbine room floor, and no high tension wiring is carried to the switchboard.

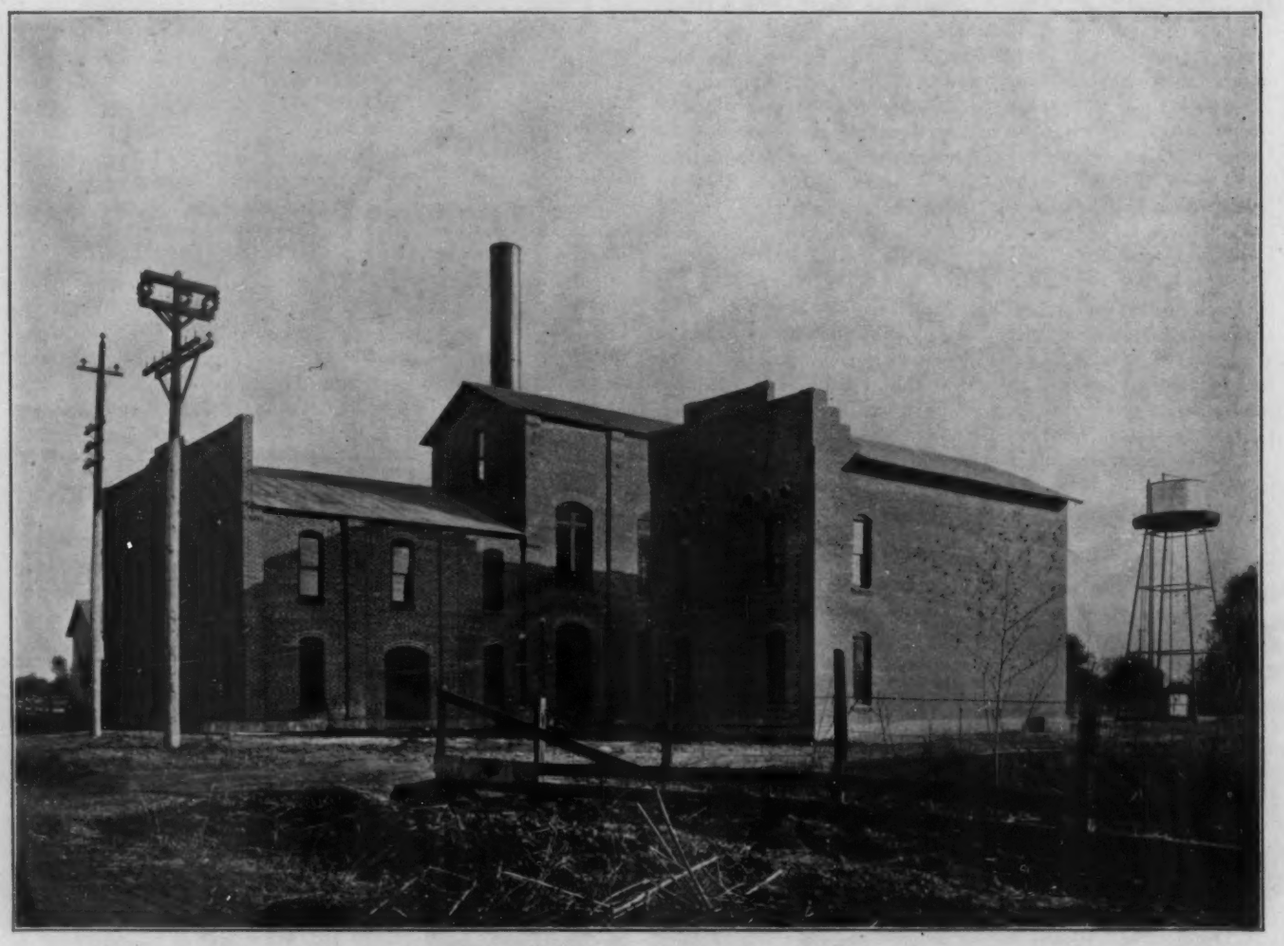


FIG. 1. BUILDINGS OF THE MT. WHITNEY POWER CO.

The buildings consist of a main power house, a high tension transformer house, and a store house. The power house is a substantial brick building with steel roof trusses and a galvanized iron roof. The front portion of the building has two floors. On the first floor are located the shop and store rooms, and on the second are two bed rooms for the operators, a large bath and lavatories, a commodious reading room for employes, a testing laboratory, and the chief engineer's office. The power house proper is practically one large room, there being no partition between boilers and machinery. Figures 2 and 3 show a sectional elevation and plan of the power house, and indicate the compact arrangement of the equipment. The boiler room and the basement of the engine room are on the same level. This arrangement affords ample light and good ventilation, and simplifies operating conditions.

Stirling water tube boilers were adopted on account of their quick steaming properties, great overload capacity, small cost of maintenance, and the short time required to clean and reconnect them for service. There are three boilers, two set in battery and one in half battery. These boilers are constructed for 200 lbs. working pressure, and each contains 3,030 square feet of heating surface. The condensing equipment, furnished by Henry R. Worthington, is immediately under the turbine and between the foundation walls. It is of the surface type, containing 3,600 square feet of effective cooling surface, and is fitted with inner air cooler and hotwell. The condensed water drains into the condenser hotwell, and is removed by a two-stage Worthington pump driven by a 5 horsepower direct connected induction motor.

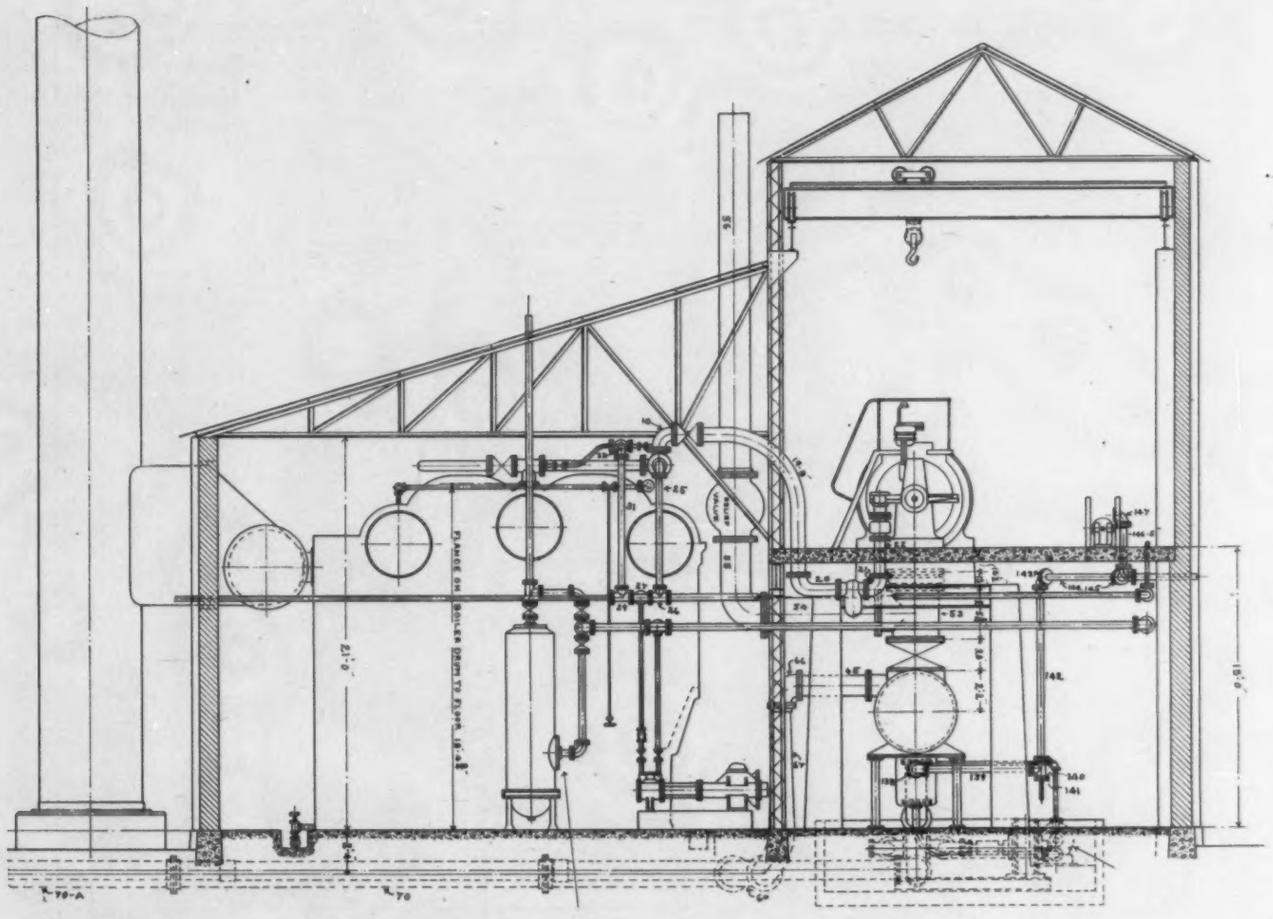


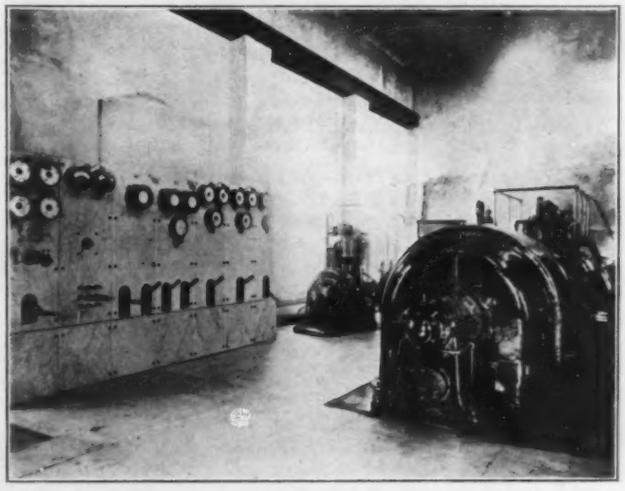
FIG. 2. SECTIONAL ELEVATION OF POWER HOUSE, MT. WHITNEY POWER CO.

The air and non-condensable vapors are removed by a direct acting steam driven dry vacuum pump located on the turbine floor. The suction and discharge valves are mechanically operated, and the clearances are reduced to a minimum. A 12-inch circulating pump of the centrifugal type is direct connected to a 50-horsepower induction motor.

As the water supply is derived from wells, it was necessary to install a cooling tower. This consists of a concrete pit, in which is mounted a suitable wooden framework which supports layers of fine galvanized iron wire cloth. The tower is divided into sections 48 inches wide and 20 inches across. The circulating water is discharged from the condenser into a main distributing box on top of the cooling tower. Lateral troughs are carried the full width of the tower, and the water is distributed to each section through openings in the walls of these troughs.

The make up water for the system is taken from a bored well by a 6-inch centrifugal pump, direct connected to a 10-horsepower induction motor. This pump discharges directly into the suction of a 12-inch circulating pump, the main circulating water being drawn from the cooling tower pit. The boiler feed pumps are of the Worthington type, 10½ by 5 by 10 inches. The fuel oil pumping system consists of two 4½ by 2¾ by 4 inch piston pattern pumps mounted on a cast iron tray, with heater, gauges and relief valve.

All steam-driven auxiliaries exhaust into a 1,000-horsepower Patterson-Berryman closed feed water heater, which raises the temperature of the water to 205 degs. Fahrenheit, and are built to take steam at boiler pressure (200 lbs.), thus eliminating the use of reducing valves, which are always a source of annoyance. The piping, valves and fittings subjected to boiler pressure are extra heavy and built to withstand a working pressure of 250 pounds. All live steam piping is insulated with an 85 per cent magnesia covering. The question of economizers and superheaters was carefully considered, and after estimates had been made of the saving under the probable operating conditions of the plant, they were considered a doubtful investment and were not installed. The step-up transformers, protective apparatus and high tension switches are located in a separate building; the transformers and lightning arresters are located on the ground



SWITCHBOARD AND EXCITER SET, MT. WHITNEY POWER COMPANY.

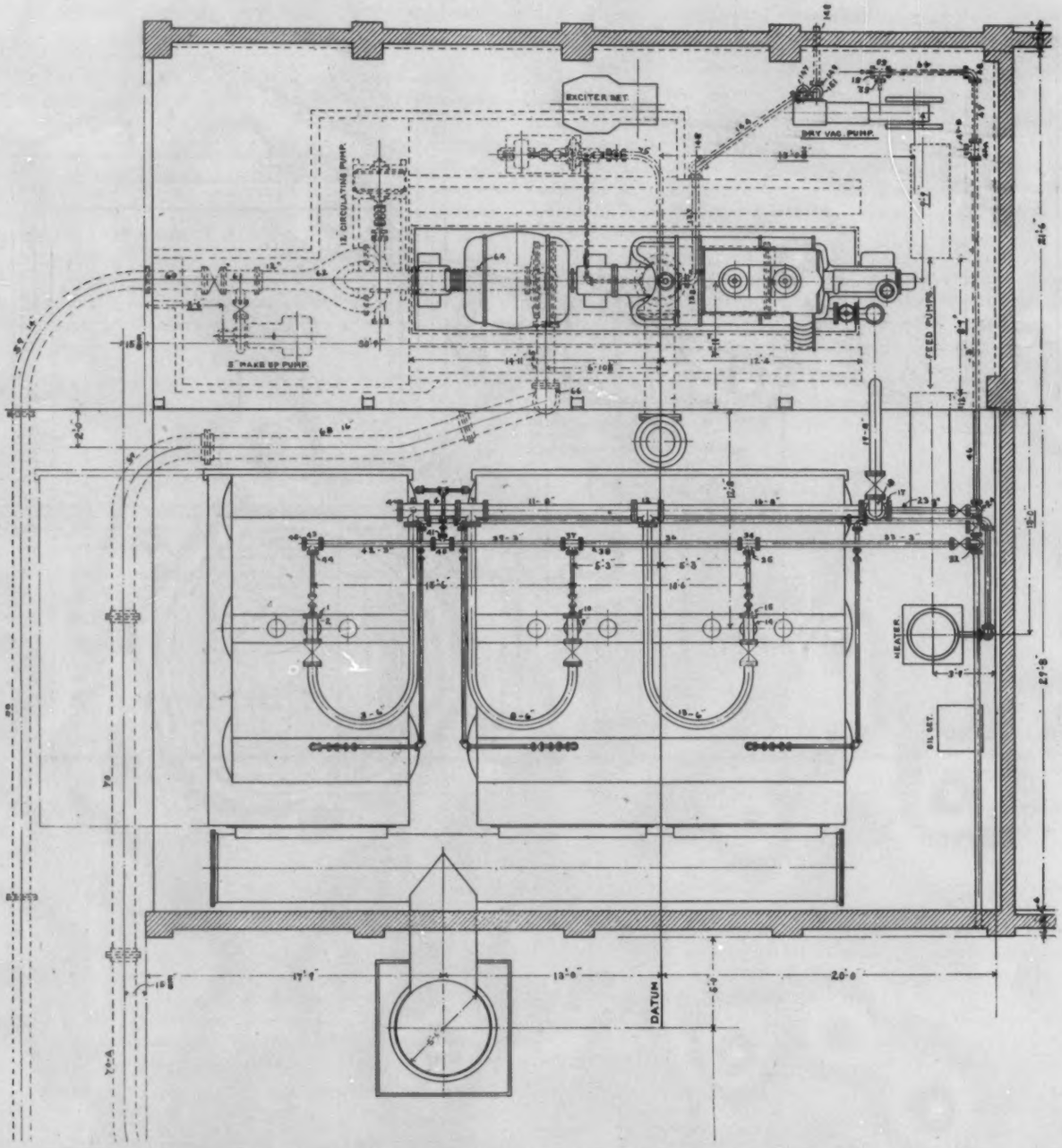


FIG. 3. PLAN OF POWER HOUSE, MT. WHITNEY POWER CO.

floor, and the high tension switches on the floor above. There are four 375-kilowatt oil insulated transformers of which the high tension coils may be connected for either 15,000 or 30,000 volts.

The external method of cooling the oil is used, and a single cooling coil is located outside of the transformer house. The oil pumped from the transformers through the cooling coil and returned again. The amount of water required for cooling can be regulated according to the load on the transformers, and during heavy overloads the temperature can be kept down to normal full load guarantees. This method of cooling is considered superior to the ordinary method of using internal cooling coils, in that, if any leakage takes place it is external instead of internal, as the pressure in the oil is greater than the water pressure.

The 2,300-volt leads from the switchboard consist of lead covered cables carried in tile ducts. Switches are so arranged on both the low and high tension sides that any transformer may be cut out of service, and the spare transformer switched in without loss of time.

This plant was completed in August, 1906, and has been operated since that time only as the necessities of the water power plant demanded, and to familiarize the operators with it. It has proven very satisfactory in every way, and synchronizes readily with the water power station.

The entire plant was installed for the company by Hunt, Mirk & Co., Inc., who acted as purchasing agents, and designing and supervising engineers. The work was carried out on a cost plus a percentage basis, which plan was found advantageous, and very satisfactory to the company. The running tests were made by taking the kilowatt-hour output of the station per barrel of fuel oil burned, and showed material increase in efficiency over that calculated when the plant was designed. For the information contained in this article we are indebted to Mr. C. H. Holley, who is chief engineer for the Mount Whitney Power Company.

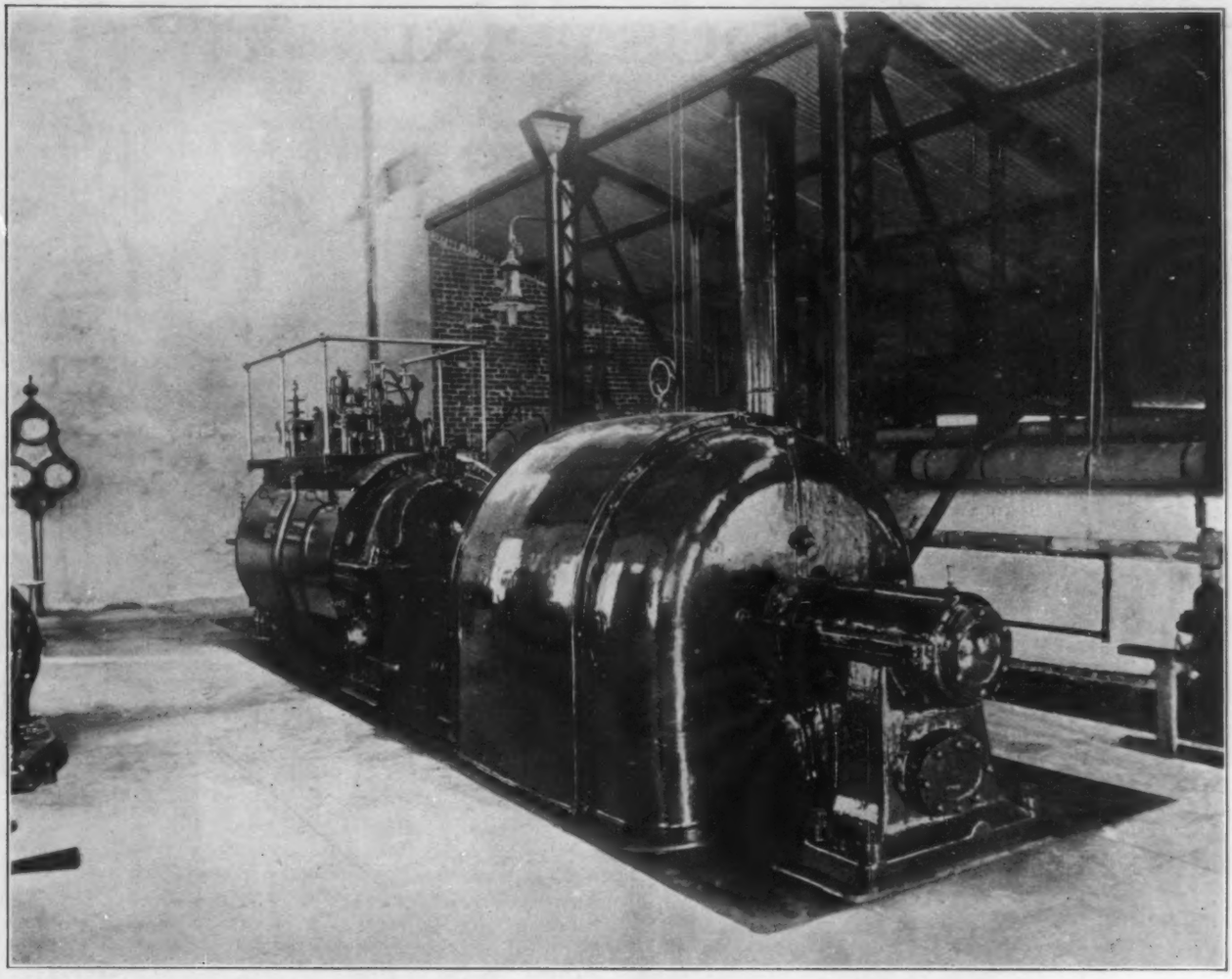


FIG. 4. 1000-KILOWATT WESTINGHOUSE-PARSONS STEAM TURBINE AND GENERATOR, MT. WHITNEY POWER CO.

MINERAL PRODUCTS OF THE UNITED STATES.

The mineral products of the United States for the calendar year 1905 amounted to a total value of $1,623,877,127, according to the report of the United States Geological Survey, issued in November, 1906. In 1904 the value was $1,360,883,554. The production of pig iron in 1904 was 16,497,033 tons, with a value of $233,025,000. In 1905 this production amounted to 22,992,380 tons with a value of $382,450,000. The production of copper was 812,537,267 pounds in 1904, with a value of $105,629,845, and in 1905, 901,907,843 pounds, valued at $139,795,716. Of aluminum, the production in 1904 was 8,600,000 pounds, with a value of $2,477,000; in 1905, 11,347,000 pounds were produced, valued at $3,246,300. The production of platinum for 1904 was 200 ounces, value, $4,160; in 1905, 318 ounces were produced, with a value of $5,320. Of the non-metallic minerals, 668,538 pounds of sheet mica, with a value of $109,462, were produced in 1904, and 851,800 pounds were produced in 1905, having a value of $185,900. Of the metal tungsten, which is grouped with unspecified mineral products, the value of $268,676 is given to the production for 1905.

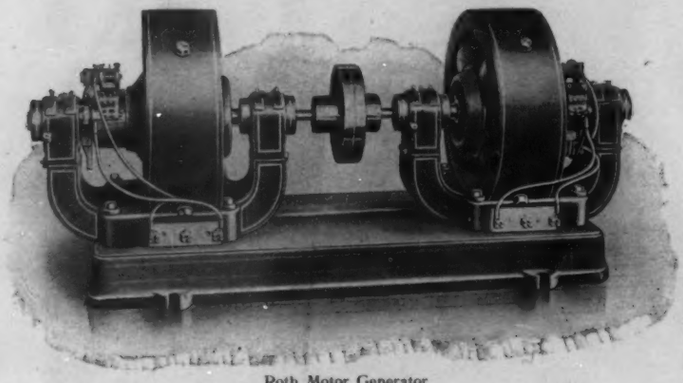
WIRELESS TELEGRAPHY AND TRAWLING.

A novel use for wireless telegraphy has been found in America. One of the large fishing fleets has adopted wireless telegraphy as a means of keeping track of the shoals of fish that haunt the Atlantic coast. The Fisheries Company controls a herring fishing industry of the coast, operating from Maine to Charleston, S. C., having factories centrally located at different points along the coast. It possesses a fleet of forty steamers, and its object in adopting wireless is to get in closer touch with the fish as they traverse the Atlantic seaboard, as well as keeping in touch with its steamers from the shore. It will arrange to communicate with coastwise steamships equipped with wireless, and in this way learn of the movements of fish that may be sighted by these coasting steamships. It will also be in position to use wireless to advantage in keeping its fleet posted. Thus part of its fleet may be near Sandy Hook cruising for fish, while the other part may be off Virginia, and in the event of their finding fish at either point they could at the moment notify each other and all assemble without delay to the location where the fish are being caught. If the above installations prove satisfactory, the Fisheries Company propose to install wireless on the remainder of its fleet. Six steam vessels have now been equipped with the De Forest system.—"The Electrical Engineer" (London).

INDUSTRIAL

ROTH ELECTRICAL MACHINERY.

Of the power developing contrivances which engineering skill has thus far been able to put forth, electro-magnetic machines have undoubtedly reached the highest state of perfection. The demand for this class of machinery is so great and competition is so keen, that the successful manufacturer must not only embody in his machines those qualities which mean reliability, long life, economical running and



Roth Motor Generator

slight attention, but, in addition, special features which make his products compare favorably with those of other energetic concerns. Roth Bros. & Co., 27-29 South Clinton street, Chicago, are producing a class of machines adapted for general use in machine shops, laundries, bakeries, factories, grocery and candy stores, and other commercial establishments.

The motors may be either belted, or direct connected by couplings or gearing with shafts at an angle of 90 degrees, 45 degrees, or at any other angle desired When belting is used the motors may be suspended from the ceiling or wall, or fastened to the floor. Generally, both motors and dynamos are of the semi-enclosed type, but for dusty or exposed places cover plates are provided, which make the machines proof against moisture, dust and other objectionable matter.

Roth Motor

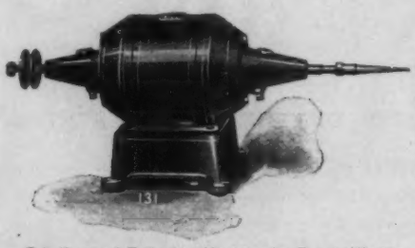
Dynamos are built for lighting purposes with capacities for supplying circuits containing from 2 to 300 sixteen-candlepower lights, and are ordinarily wound for 110 and 220 volts. The motors are built in sizes ranging from one-sixteenth to twenty horsepower, and are furnished series, shunt or compound wound. There are many special forms, among them being the back-geared motor and the electrical countershaft for driving machine tools, the ringing generator for telephone work, vertical motors for driving electro-typing machinery, and many others.

Electric Forge Blower

An extensive line of motor-dynamo sets is also manufactured by this firm. These are suitable for use on telegraph lines, for charging batteries, ringing call bells, operating signals, magnetizing coils, electroplating, electrotyping, and as boosters, equalizers, etc.

Large Motor Driven Grinding and Polishing Machine

The electric forge blower, as shown in the



Grinding and Polishing Machine for Bench Work

illustration, is a unique combination of motor and blower which can hardly be excelled for compactness and convenience. A mere turn of the starting box lever produces a steady blast of air on the fire and relieves the blacksmith from trying to do two things at one time, which is necessary in the old way. These blowers are constructed for both heavy and light work and for use on both alternating and direct current circuits.

Considerable attention is devoted by this firm to the manufacture of motor-driven grinding and polishing machines. The larger machines are mounted on cast-iron stands which may be fastened to the floor. A very important feature is the large working radius, which enables the operator to grind and polish long pieces with the face of the wheel and not with the corners. This is made possible by giving the magneto-frame a peculiar shape. The poles are steel castings of round cross-section and therefore permit the use of circular coils which are the most efficient.

Two hand holes are bored in the frame to give access to the brushes and commutator and two peep holes are pro-

vided so as to avoid the necessity of removing the hands to see inside of the machine.

By means of a speed regulator it is possible to obtain the speed best adapted to the work in hand by the simple movement of a lever.

Small grinding and polishing machines are also made for light work. These are not fitted to high stands, but are mounted on low bases for bench work.

ELECTRIC SOLDERING TOOLS.

The Vulcan Electric Heating Company, of Chicago, is publishing in our advertising pages of this issue an invitation for all Pacific Coast visitors at the Chicago Electrical Show, January 14th to 26th inclusive, to call at its exhibit, space 14, at the left of the main entrance, where high temperature electric soldering and branding appliances will be shown in full operation and the practicability and superiority of electrically heated tools clearly demonstrated.

Although electric soldering tools have been on the market for a number of years and have been tested many times, the results have, until recently, been quite unsatisfactory, and the majority of possible users have been of the opinion that satisfaction and economy could not be depended upon in the use of these tools.

The Vulcan Electric Heating Company now comes forward with the offer to guarantee satisfaction; its confidence being based on the behavior of thousands of these tools sold during the year 1906, many of them to large plants in which economy is a very important item, where the tools were thoroughly tested and adopted only on the strength of economical operation and improved results.

It is, therefore, an item of great interest to those engaged in soldering and branding operations, that the above mentioned company proposes to exhibit at Chicago a line of thoroughly satisfactory electrically heated tools, in connection with instruments which will register the current consumption, enabling the visitors to figure the actual cost of operation and make actual tests of working efficiency.

The claim is made that these tools will be shown to be superior to the gas-heated article in economy, convenience and reliability, and that they will be found thoroughly practical in service.

While it is presumed that many interested parties here on the Coast will be unable to see this demonstration, it is hoped that those who do attend the Chicago Electrical Show in January will take advantage of this opportunity.

What we want here on the Coast is the best that can be procured and operated with the greatest possible economy. It goes without saying that the electrically heated tool will eventually supersede the cruder arrangements, and we sincerely hope that the Vulcan Company's efforts to introduce them will succeed.

We have been informed that the Vulcan Electric Heating Co. will open a vigorous selling campaign on the Coast, through the various dealers, central stations and contractors. The company has the reputation of standing behind the quality of its product and making good all faults.

A red hot branding tool will be operated in branding souvenirs for visitors. A large electric soldering tool running a continuous seam, satisfactory electric soldering tools, solder pots, wax pots, etc., will also be exhibited. It is hoped that some of our engineers and practical men will investigate these appliances and report their opinions.

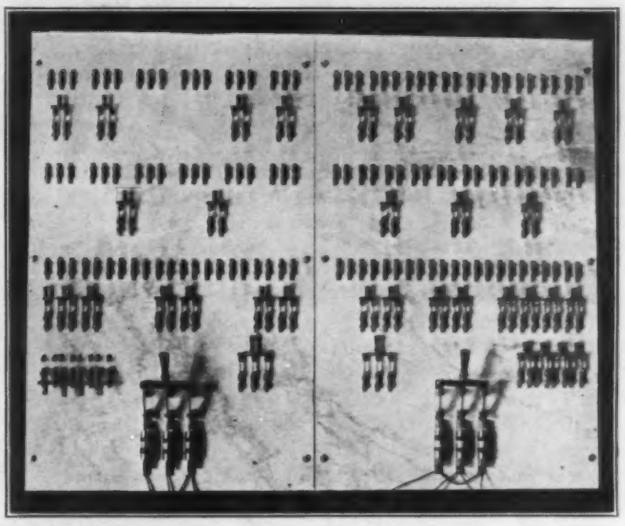
A NEW PLANT.

The Geo. E. Dow Pumping Engine Company, which suffered severely in the April fire, succeeded in re-establishing itself on a large basis, and during the past four months has kept its works in full operation. The present location of the works is on the old site, which constitutes the block bounded by First, Howard, Fremont and Natoma streets. This is, however, only temporary, as the company is planning to build a permanent plant on ten acres of land lying on the Alameda side of the Tidal Canal. The iron foundry will be 150 by 450 feet, and the main machine shop 150x600 feet. The company will generate electric power in a station to be equipped with machinery of its own manufacture, with the exception of the generators.

The new plant is being designed with an eye to obtaining a maximum efficiency, and will be one of the most complete plants of its kind in the West. As a sign of present progress, the company reports having double the work on hand that it had previous to the fire, which is a significant example of the fact that it pays to specialize in manufacturing.

PROGRESS OF A SAN FRANCISCO FIRM.

The Bay Shore Electrical Construction Company, 186 Second street, announces that its repair shop has now reached a standard which entitles it to be classed with the best equipped shops on the Coast. It is particularly strong in facilities for rewinding armatures, a class of work on which



Switchboard recently constructed for the American Theatre, San Francisco, by the Bay Shore Electrical Construction Company.

this company has built up a reputation in San Francisco and neighboring towns and cities.

Aside from continuing its work in general electrical construction, this company is about to undertake the extensive manufacture of switchboards, panels, marine fittings and other electrical auxiliaries. Its stock of Barriett motors is now complete. Several sales of these, under the customary guarantee for one year, were recently reported.

NEW RECEPTACLE FOR INCANDESCENT LAMPS.

The Benjamin Electric Mfg. Co., of Chicago, are placing upon the market a new No. 6-B receptacle specially designed for use with outlet boxes. It has a number of strong, attractive features, among which may be mentioned the following: Its contacts do not project beyond the walls of the receptacle, and therefore do not readily come in contact with the metal parts of the box or projecting parts of the conduit; wires are easily spread around the base, thus making slack wire unnecessary; the binding screws are accessible from the front, thus obviating the necessity of reversing the receptacle or of tapping wires to make connections; it

may be connected while in position in the box, the cover being attached after electrical connections have been made.

A steel plate cover is furnished, together with a polished brass cover. Where desired a shade holder is spun upon the latter, thus forming a part of it. The result is a neat, substantial and serviceable article.

ELECTRICAL SHOW AT CHICAGO.

Chicago's second annual electrical show, which will be held in the Coliseum from January 14th to 26th, 1907, will be the banner trade booster of the United States. More than 30,000 square feet of the main floor of the Coliseum has been sold to one hundred and fifty of the leading manufacturers and jobbers of electrical supplies, many of whom will make displays for others as well as for themselves. Not a single branch of the electrical field will be overlooked, and the exhibits, as a whole, will be greater and more elaborate than they were in the show of a year ago. At this writing there are but five spaces left on the main floor, the complete list of exhibitors being as follows:

Armour Institute; American Steel & Wire Co.; American Telegraph & Telephone Co.; Automatic Electric Co.; Allis-Chalmers Co.; American Telephone Journal; Aetna Stage Lighting Co.; Anderson, Albert & J. M. Mfg. Co.; American Clock Co.; American Vibrator Co.; Antiseptic Co., The; American Electrical Novelty & Mfg. Co.; American Sewer Pipe Co.; American Electric Heater Co.; Burns, W. J.; Bryan-Marsh Co.; Bryant Zinc Co.; Brilliant Electric Co.; Bidwell Electric Co.; Beck Flaming Lamp Co.; Bishop Gutta Percha Co.; Baton Electrical Mfg. Co.; Bossert Electric Construction Co.; Crockett, W. P. Co.; Chicago Telephone Co.; Chicago Pneumatic Tool Co.; Cook, Frank B.; Cooper-Hewitt Electric Co.; Central Electric Mfg. Co.; Chicago Battery Co.; Chicago Edison Co.; Crane Co.; Central Electrical Co.; Chicago Lamp & Reflector Co.; Chicago Compound Battery Co.; Commonwealth Electric Co.; Crescent Wire & Cable Co.; Crawfordsville Wire & Nail Co.; Crescent Co.; Columbia Incandescent Lamp Co.; Colonial Electric Co.; Crouse-Hinds Co.; Dixon, Joseph, Crucible Co.; Dossert & Co.; Duncan Electric Mfg. Co.; Diehl Mfg. Co.; Dean Electric Co.; D. & W. Fuse Co.; DeVeau Telephone Co.; Bigley Tel. Co.; Dale Co., The; Dittrick-Jordan Electric Co.; Eureka Electric Co.; Engineer Pub. Co.; Edwards Electric Headlight Co.; Electric Appliance Co.; Electric Rotary Floor Polisher Co.; Electric Storage Battery Co.; Electrocraft Publishing Co.; Electric Service Supplies Co.; Electrical Review; Erwin & Co.; Electrical World; Engineering World; Edison Mfg. Co.; Electric Cable Co.; Enamel Metals Co. (Enameled); Ft. Wayne Electric Works; Federal Electric Co.; Faries Mfg. Co.; Grubbe, Emil H., M. D.; Guarantee Electric Co.; Gould Storage Battery Co.; General Electric Co.; Haller Machine Co.; Haines, J. Allen; Holzer-Cabot Co.; Hamburger, Felix; Helios Mfg. Co.; Hepburn Tel. Co.; Hart Mfg. Co.; Hunter Illuminated Car Sign Co.; Indiana Rubber & Insulated Wire Co.; Johns-Manville Co.; Kellogg Switchboard & Supply Co.; Keystone Electrical Instrument Co.; Lang, J., Electric Co.; Locke Insulator Mfg. Co.; Lyon Metallic Mfg. Co.; Monarch Electric & Wire Co.; Mathews, W. N. & Bro.; Metropolitan Electrical Supply Co.; McRoy Clay Works; Miller Anchor Co.; National Carbon Company; National Battery Co.; Nernst Lamp Company; Nungesser Battery Co.; Nurnberg Flaming Arc Lamp Co.; New York & Ohio Co.; Nuttall Co., R. D.; Oliver Mfg. Co.; Ohio Brass Co.; Oneida Community, Ltd.; Okonite Co., Ltd.; Peabody Coal Co.; Phoenix Glass Co.; Petersen, H. A. Mfg. Co.; Peirce Specialty Co.; Public Service; Phelps Co.; Paiste Co., H. T.; Phillips Insulated Wire Co.; Packard Electric Co.; Protected Rail Bond Co.; Reynolds-Dull Flasher Co.; Roth Bros. & Co.; Rock Island Battery Co.; Reed Electric Cordage Co.; Shelton Electric Co.; Schureman, J. L. Co.; Stromberg-Carlson Telephone Co.; Swedish American Telephone Co.; Simplex Electric Heating Co.; Schott, W. H.; Stolz Electrophone Co.; Sangamon Electric Co.; Stanley & Patterson, Inc.; Sarco Co., The; Sterling Electric Co.; Sterling Varnish Co.; Speer Carbon Co.; The Consumers Co.; Telephony Pub. Co.; Universal Mfg. Co.; Universal Electric Storage Battery Co.; University of Illinois; Vulcan Electric Heating Co.; Vim Company; Vote-Berger Co.; Vesta Accumulator Co.; Wagner Electric Mfg. Co.; Western Electric Co.; Westinghouse Electric & Mfg. Co.; Western Electrician; Western Insulator Co.; Wilson Trolley Catcher Co.; Wire & Telephone Co. of America; Whitney Electrical Instrument Co.

Following the precedent established by the directors of the Electrical Trades Exposition Company a year ago, Managing Director Niesz is sparing no expense or effort to make the coming show the greatest and most interesting trade exposition ever held in Chicago. It will be more than liberally advertised and special inducements will be offered to attract the attention of the public to the affair. The 201st anniversary of the birth of Benj. Franklin will be marked by a special program Thursday, Jan. 17, and handsome souvenirs will be distributed. Monday, Jan. 21, will be "telephone" day, and another appropriate souvenir will be given away. Thomas A. Edison day will be observed Wednesday, Jan. 24, an occasion for another souvenir. During the two weeks of the exposition there will be several important meetings of electrical organizations, notably the Northwestern Electrical Association, which has its annual convention at the Coliseum January 16, 17 and 18. This affair is usually held in Milwaukee, but as a compliment to the Chicago members of the organization, many of whom are identified with the electrical show, the meetings are to be held in Chicago. The Sons of Jove will have a rejuvenation on Wednesday night, Jan. 16, and the Illuminating Engineers' Society will meet Thursday, Jan. 17. The American Electrical Salesmen's Association will have its annual meeting Wednesday, Jan. 24.

Ellery's Royal Italian Band has been engaged for afternoon and evening concerts throughout the two weeks of the show and the Coliseum Annex will be converted into an electrical "Midway." Several new and interesting amusement features along electrical lines have been secured.

A PRACTICAL TEST OF THE TIRRIL REGULATOR.

The Tirril automatic voltage regulator consists in principle of a vibrating tongue which short-circuits the field-regulating resistance of the generator or of the exciter several hundred times a minute. The proportion of each period during which the short-circuit lasts is automatically varied according to the generator volts, with the result that the generator voltage can be maintained practically constant in spite of variations of load or speed. In a paper recently read by Her Klicpera, before the Electrotechnik and Machinenbau, some very interesting results obtained by the use of this regulator are described. The station is an alternating current one, and among its customers is a particular paper mill at a distance of 17 miles, for which a separate 300 kilowatt generator is run. Energy to the extent of 300 horsepower or 350 horsepower is required for motive and lighting purposes at the mill, as well as for about 1,200 lights and 50 horsepower in motors taken off the main between the supply station and the mill. Hand regulation was found perfectly satisfactory until last year, when a wood-sawing factory was erected at the mill. The load fluctuations then became very great (varying between 50 kilowatts and 300 kilowatts), that in spite of the greatest care, hand regulation of the exciter shunt resistance and of a resistance in the alternator field winding failed to produce a satisfactory voltage curve. Running two generators in parallel under half-load did not improve matters much, and the introduction of an ordinary automatic field regulator worked by a solenoid connected to the 'bus bars was found quite useless,

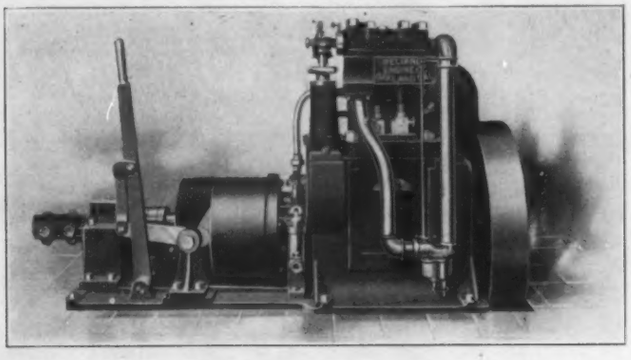
except as regards relieving the switchboard attendants somewhat.

Finally, a Tirril regulator was tried. A constant resistance was kept in the alternator field, and the regulator was arranged to adjust the voltage by intermittently short-circuiting a resistance in the exciter shunt. The result was quite satisfactory, giving a voltage curve which was practically a straight line. The regulator has been in use for nearly a year without interruption.—The Electrical Engineer (London).

A NEW TYPE OF GAS ENGINE.

The Reliance Engineering Company of Oakland has recently developed a new type of gas engine especially suitable for marine work. This company has worked persistently to put forth a design which not only permits great economy in construction, but one which is adapted to the most trying conditions met with in practice. A successful designer in this class of work must be familiar with the properties of the oils found on the market, as well as with the effects of variations in the temperature, humidity and purity of the air, which goes into the explosive mixture.

In this engine the oil is usually first passed through a fine mesh screen to separate the solid particles and grit, and then over a catch-pit to free it from moisture. To get air of a uniform and pure grade, an air jacket is placed around the lower part of the cylinders, and extends up a considerable



New Marine Gas Engine of the Reliance Engineering Co.

distance. The jacket is made large in order to give the dust in the air a chance to settle and the moisture to condense. The upper part of the jacket is quite warm when the engine is operating and heats the air to a uniform temperature. This is a necessary feature when operating in cold weather.

The splash system of oiling is used in connection with forced feed lubrication obtained by means of a small piston pump. The splash oil has the advantage that it continuously washes the grit from the working parts into the bottom of the pit, but in case the operator should allow the oil to become too low to lubricate efficiently, the most important working parts are provided with the positive oiling device operated by the piston pump.

In order to obtain the rigidity essential to smooth running the cylinders are bolted directly to the cast-iron frame of the base. This gives the engine a neat and compact appearance. Many devices are employed to prevent injury to the engine due to an oversight or blunder on the part of the operator, and to facilitate starting, a relief cam is provided to prevent compression while the crank is being turned by hand.

ELECTRIC SIGNS AND THEIR CONSTRUCTION.

Few people realize the ingenuity, skill, technical knowledge and good judgment required to successfully construct and put up electric signs. Mr. W. C. Brumfield of the Novelty Sign Company, 837 Ellis street, San Francisco, recently said that special designs should command much higher prices than are at present obtained for them on account of the extensive experience and special facilities necessary, just as the reputable surveyor receives $500 for an hour's work in performing a difficult operation.

Customers whom the advertising manager has succeeded in convincing that electric signs are paying investments, usually require several designs to be submitted. To do this work properly requires head designer and several assistants, all of whom must be skillful with the small brush and be fairly good draftsmen. The head designer must have original ideas and be able at a moment's notice to furnish sketches of signs appropriate and pertinent to the business of the advertiser.

The erection of large roof signs calls for considerable knowledge in designing metal supporting frames of ample strength to withstand maximum wind pressure without giving them a clumsy appearance. A competent electrical engineer is also necessary to secure safe and permanent ironing, and to solve problems connected with the construction of special live boarders, flashing effects, changeable letters, etc.

The man in charge of the finishing of signs must be thoroughly acquainted with the different methods of coating and the compounds used, such as fire enamel, japan enamel, air drying enamel, smalt, and others. A poorly finished sign may cost the manufacturer a great deal of money, as the finish will peel off, causing a great dissatisfaction on the part of the purchaser. Sometimes when rush orders are sent in, with instructions to deliver by a certain day or not at all, the finish is not given sufficient time to dry, with the result that its durability is destroyed.

Since the fire about three hundred electric signs have been put up in San Francisco, and judging from the way orders have been coming in recently, the Novelty Sign Company believes that in a short time the display will equal that of the days before. And, considering the progressiveness of the San Francisco business element, the time will come when her main thoroughfare, like that of New York, will be known by night as "The Great White Way."

SPLICING BROKEN ARMATURE PARTS.

A method of splicing broken armature shafts which is proving satisfactory has been developed at the Columbus, O., shops of the Indiana, Columbus & Eastern Traction Company. Shafts broken near the gear or on the taper at the pinion end are easily repaired so that the armature may be used until it is necessary to tear down the winding for some other reason.

The method of making this splice is simple. The broken end of the shaft is turned down in the form of a cone, longitudinal grooves being cut in its surface. After this is done another piece of shaft steel is hollowed out, cup-shape, to fit the taper snugly. One-fourth of an inch of spelter is placed in the bottom of the cup. The two parts are fitted together and placed in a screw jack or wheel press and are then heated by means of a coke air-blast flame which is made to circle around the shaft. As the parts to be spliced are heated pressure is applied through the screw jack and the spelter is forced from the bottom of the cup to all parts of the taper. When the shoulders of the two pieces are brought together the weld is complete. The shaft is then placed in the lathe centers and trued. The method described has been used very successfully and in many instances the welded shafts are still in use after several months of severe wear.—"Electric Railway Review."

NEWS NOTES

ELECTRIC RAILWAYS.

Sacramento, Cal.—The report was current last week in San Francisco that negotiations were pending in New York for the sale of the Pacific Gas & Electrical Corporation to the Western Power Company, a corporation allied with the Western Pacific. The Pacific Gas & Electrical Corporation controls the Sacramento Electric, Gas and Railway Company of Sacramento, and reports were current in that city that the street car line here had passed into the hands of the Gould interests. The story, however, is denied by John A. Britton of San Francisco, General Manager of the Pacific Gas & Electric Corporation. Mr. Britton declared emphatically that there was no was no truth in the report. He said that the Pacific Gas & Electric Corporation had not sold out to the Western Pacific, the Western Power Company, the Gould interests, or to anyone. The Sacramento street car system was inspected during the past week by a corps of engineers, and their visit, together with the report that negotiations for the sale were being made, is what gave rise to the report that the road had changed hands. It is said, however, that the engineers were merely representatives of the bond holders who make annual inspections of the holdings of the corporation, and that their visit was not out of the ordinary.

Boise, Ida.—The Boise R. R. Co. has been incorporated for the purpose of purchasing the Natatorium & Boise Traction Co. Capital stock, $900,000.

Caldwell, Ida.—Henry W. Dorman has applied to council for the construction and operation of an electric line in this city.

Lewiston, Ida.—It is reported that the Walla Walla & Columbia River Traction Co., will, the first of the year, place surveyors in the field at Dayton, Wash., to commence work on a permanent survey of an electric line to this place.

Spokane, Wash.—Work has been commenced by the Washington Water Power Co. placing its electric light and power wires under ground. The work will cost $500,000.

FINANCIAL.

Pacific Grove, Cal.—A transfer of the control of the Monterey and Pacific Grove Electric Railway has taken place. C. W. Allen and R. C. P. Smith have sold their interests in that line and in the Monterey County Gas and Electric Company to George Heazelton of San Francisco and E. P. Bolles, President of the First National Bank of Oakland. Extensions of the present Presidio line, through Pacific Grove to Carmel-by-the-Sea, and from Del Monte to Vista del Rey, are projected, as is also a line to Salinas. W. H. P. Hill has been appointed Manager.

San Francisco.—Holders of 3,843 shares of the California street cable road, which represents considerably less than a majority of the stock, held a meeting a few days ago, at the request of President Stetson, and unanimously voted down the proposition of selling to the United Railroads. The proposed sale has been talked of for several months. In fact, before the fire there was considerable talk of a merger with the United Railroads, but no agreement as to values could be reached.

Redding, Cal.—The Northern California Power Company has secured a permanent injunction in the Superior Court against the Shasta Power Company, a rival concern, preventing it from stretching its wires over the wires of the complaining company. Under the conditions of the injunction, the new company must stretch its wires beneath them and raise the Northern California Company's wires at its own expense.

TELEPHONE AND TELEGRAPH.

Berkeley.—Initial steps were taken at the meeting of the Conference Committee of the improvement clubs last week to consider the legality of the action of the Town Trustees in allowing the Home Telephone Company a fifty-year franchise in the ordinance passed to print at the recent meeting of the City Council. The objection to the fifty-year franchise on the part of the improvement clubs is based on the ground that the rival company will be enabled to gain back its initial expense of laying lines in a period of ten years, the operations during the remainder of the fifty-year term being clear profit. Victor J. Robinson, who acted as chairman, expressed himself as believing that a gift had been tendered the company by this long franchise.

Los Angeles.—An ordinance has been passed by the Council creating a conduit district and prohibiting the erection of poles and wires within the district.

Ukiah.—It being proposed to grant Charles L. Dearborn of Melbourne, Mendocino County, Cal., a franchise to erect and maintain a pole line for conducting telephone and telegraph lines over certain highways in Mendocino County, sealed bids will be received up to January 29th by the Board at Ukiah, Cal., for such franchise.

Marysville.—The Town Trustees of Wheatland have received application for a telephone franchise, the line being promoted by the dredger operators on Bear River, to run across the Horst and Drescher lands into Wheatland.

Mendocino.—The new Melbourne telephone line will probably be extended to Orr's Springs soon. This line has been constructed by private parties.

Petaluma.—A new direct telephone line will soon be built from Petaluma to San Francisco. Other additions are the building of through lines from Ukiah to Wendling and Albion, Mendocino County.

Arroyo Grande, Cal.—Arthur Tulford and James Fulton of San Luis will construct a telephone line between Arroyo Grande and the Crystal Oil Company's well.

Helena, Mont.—The Montana Independent Tel. Co. has had plans drawn for the erection of an exchange at this place to be completed June 1.

Spokane, Wash.—The manager of the Pacific States Tel. & Tel. Co. states that $175,000 will be expended by the company in improving its service in this city.

Sherwood, Ore.—The Sherwood Mutual Tel. Co. has been incorporated by J. P. Young, L. S. McConnell and Ferd Langer.

Baker City, Ore.—R. C. Robertson and associates, of Portland, have applied for a 20-year franchise for a new telephone system.

Wilson Creek, Wash.—The Wilson Creek Tel. Co. will incorporate with a capital of $2,500.

Aberdeen, Wash.—The Sunset Tel. Co. has moved their exchange into their new building on Wishkah St.

Boise, Ida.—The Independent Long Distance Tel. Co. will on January 14 vote to increase their stock from $750,000 to $1,000,000.

Bellingham, Wash.—The Farmers' Mutual Tel. Co. decided to erect a brick building for station purposes at Lynden. The company is also erecting a new line between Ferndale and the Anatole district.

Kent, Wash.—A. T. West has applied for a franchise for the erection and maintaining of a system of telephone or telegraph lines in Kent.

POWER AND LIGHT PLANTS.

Ashland, Ore.—R. McMurphy and associates have applied for a 25-year franchise for a gas heating, light and power plant.

Grace, Ida.—The Telluride Power Co., of Salt Lake City, will construct a power plant here at a cost of $1,000,000.

Kalispell, Mont.—The Flathead Valley Water Power Co. has incorporated with a capital of $350,000 by A. W. Howard, Russell M. Simmons, P. H. Bartelme, Warren Nichols and H. D. Folsom, Jr.

Starbuck, Wash.—Dr. M. Pretrycki will build an electric light plant at this place.

Seattle, Wash.—The municipal water and lighting department has received word that the carload of wire has been shipped from Newark, N. J., and will arrive here about January 10.

Tenino, Wash.—W. A. Freeburger, of Montesano, has purchased a controlling interest in the plant of the Tenino Light & Water Co.

Wenatchee, Wash.—The Wenatchee Electric Co. will increase its capital stock from $25,000 to $150,000. The company plans extensive improvements.

Baker City, Ore.—J. K. Rowing, president of the Eagle River Power Co., has closed a contract with the General Electric Co. for a complete equipment of machinery to develop 2,500 horsepower at the new Eagle River power plant at Sanger.

Trent, Wash.—Work has been started by the Trent Power & Irrigation Co. on the power plant which is to develop 1,500 horsepower.

Selma, Cal.—The San Joaquin Power & Light Company has about consummated a deal for the purchase of the Selma Light & Water Company. Manager Wishon, of the electric company, anticipates the successful culmination of the deal and expects the new company to be in charge by the first of the new year.

The Palms, Cal.—Arrangements have been completed for the building of an electric light plant here. Public subscriptions have been received sufficient to pay for lighting of the city for six months.

Ely, Nev.—This city is to have another modern electric light plant, and actual work of construction has already started. William V. Lockwood, who built a power and lighting plant here several years ago, has formed a new company and intends to give the mines of Ely more power and light and to expend over $100,000 in building a power house and equipping it with the latest electrical machinery.

Loyalton.—This city is agitating the purchase of the local lighting system and plant.

Vallejo.—The Vallejo Gas Company is again enlarging its plant.

Compton, Cal.—Sealed bids will be received by the Board of Trustees up to February 19th for a franchise for the construction and maintenance of poles, wires and other apparatus for furnishing electrical energy for lighting, heating and power purposes. A certified check for the full amount of the bid required should accompany each proposal, being made payable to the City Treasurer.

Compton.—The Trustees have an electric light franchise for sale, which will be purchased by G. R. Fulton. As soon as legal forms are complied with a company will commence

Pasadena.—The contract for the erection of a corrugated iron building to house the municipal electric light plant, has been let to Ellsworth & Co. for $1,748.

Santa, N. M.—Application has been made to the Town Council of Aztec, N. M., by H. H. Matheson for a franchise to erect and operate an electric light plant and furnish current for lighting and other purposes. He says it will take about sixty days to install this plant.

TRANSPORTATION.

Oakland.—The contract has just been let to the Hammond Lumber Company for 6,000 piles, the first section of what is practically an almost unlimited order for the construction of the new harbor docks and terminal basin of the Key Route system, which, when completed, from the estimates of the consulting engineer, Howard Holmes, will involve an expenditure of $10,350,000. The real purpose of the application of the Key Route people for a franchise on Wood street has also come to the surface in the full outline of the plans of the company for the construction of this new harbor. According to the plans, they will dredge out the basin in front of the bulkhead, which they have constructed to a depth of thirty feet at low tide, thus enabling vessels of the largest draft to enter the basin and moor alongside the berths. These docks will be 100 feet wide and 1,000 feet long, and will give room for 228 ships. Each dock will be reached by a spur track, and thus it will be possible to load the consignment of silks and teas and other products of the Orient directly from the ship to the freight cars. One of the most important provisions in the plan is for the ferrying of freight cars from the basin to San Francisco, thus enabling Eastern shippers on independent lines to come to tidewater and have their cars transferred to the San Francisco water front.

San Francisco.—The Board of Supervisors has passed, unanimously, a resolution of intention to rebuild the Geary street cable system for the city, with an overhead trolley equipment. The route of the proposed municipal electric road is to be along Geary street, Point Lobos avenue and Tenth avenue, southward to Golden Gate Park. The clerk was instructed to prepare the necessary orders and ordinances to initiate the proceedings of taking possession of and rebuilding the road.

Napa.—W. M. Rank, Manager of the Napa and Lakeport Electric, with a party of five people, has been over the proposed route.

Los Angeles.—The Interurban Railway has secured a fifty year franchise. The Fourth street franchise is directly in line with the proposed extension of the Los Angeles Railway through Eagle Rock Valley and Glendale, and is likely to be turned over by the Interurban.

Los Angeles.—Monday is the day set for passage of the privilege permits asked for the Harriman interests, which seek to build subways under public and private streets in Los Angeles about six miles long, and also extensions of surface lines to connect new and old routes.

Torreon, Mex.—Dr. J. Limm of the Mexico-Chinese Bank in this city has obtained from the government of the State the concession to build another electric street car line here. Work will commence in four months.

Chihuahua, Mex.—The city of Parral is to have an electric street car system. Local capitalists of that place have organized a company for that purpose. C. H. Bailey and Leopoldo Iwonsky are among them.

Los Angeles, Cal.—Arrangements have been made with H. E. Huntington whereby the present Stephenson avenue line of the Los Angeles railway, which terminates at Indiana street and Stephenson avenue, will be extended up Indiana street to Fifth street. The new car line will be in operation in a month.

Los Angeles, Cal.—It is rumored in railroad circles that the St. Louis Car Company is considering establishing a plant here for the manufacture of electric cars.

Bisbee, Ariz.—The Bisbee district is soon to have an electric railway which will extend from Bisbee and touch as many of the Copper Queen and C. & A. mines as the topography of the country will permit. Bids for the construction are being advertised for.

TRANSMISSION.

Redding.—The Northern California Power Company will erect a new plant on the mouth of the Jenny Creek, and surveys for the pipe line will be commenced as soon as the company's engineer arrives.

Modesto.—The Board of Supervisors will receive bids up to January 16th for the installation of an electric plant for pumping purposes at the County Hospital, according to plans and specifications on file with W. J. Marin, Clerk.

Los Angeles.—H. H. Clark, a prominent mining man of Nevada, is in the city, and states that he proposes to develop electricity from the Kings River high up in the Sierras on the dividing line between California and Nevada. Thus far he alone is interested in the project, which will mean an expenditure of not less than $6,000,000 in the construction of dams, generating plants, transmission lines, which will convey power to Los Angeles, San Francisco and the various mining camps in Western and Southern Nevada. The site of the proposed plant is near the narrow gauge road running from Sodaville, Nev., to Keeler, Cal., which is controlled by the Southern Pacific. Mr. Clark will soon leave for Niagara Falls, where he will inspect the big electrical power plants and decide upon the machinery necessary.

Venice.—The miniature plant at the north end of the Breakwater, built for demonstrating purposes, has passed into the control of the Los Angeles Wave Power and Electric Company, a new concern incorporated under the laws of Arizona with a capital of $3,000,000. E. C. Phipps, one of the new company, was identified with the builders of the local plant, and will continue to make his headquarters here. Inventor Fred Starr and J. H. Bacon, promoters of the Starr Wave Motor Company, have left for Washington, D. C., from which point they will go to Atlantic City, N. J., to begin work on the construction of their proposed commercial plant.

POWER AND LIGHT PLANTS.

San Jacinto, Cal.—Messrs. R. G. Dunn, C. A. Watson, and Horace Slater, of Redlands, the promoters of the gas plant for San Jacinto and Hemet, are in the valley making arrangements. The mnaufacturing plant will be established on Menlo avenue, on the Santa Fe R. R., midway between San Jacinto and Hemet. Construction work will comemnce in the immediate future.

Redding, Cal.—The plant of the Redding Gas Company, owned by the Northern California Power Company, is to be enlarged immediately by the addition of a new gas holder, or tank. The new holder will have a capacity of 15,000 cubic feet, while the one now in use has a capacity of 10,000 cubic feet. Bids are now being advertised for the installation of the new holder.

Calgary, Alta.—W. M. Alexander, of Brandon, Man., has applied for a franchise to build and equip an electric light plant, also an electric street railway.

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